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Engineering Library


# ENGINEERING:

## An Illustrated Weekly Journal.

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**Aveling & Porter, Ltd.,**
ROCHESTER.
Steam & Crude Oil Road Rollers, &c.
2581

**A. G. Mumford, Ltd.,**
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement page 19.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

**Dredging Plant**
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, LTD., FRIARS HOUSE, 39-41, NEW BROAD ST., LONDON, E.C.2.
*See half-page Advert. last week and next week.* 2087

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GEORGE RUSSELL & CO., LTD., Motherwell. 2591

STEEL TANKS, PIPES, GASHOLDERS, &c.
**Thos. Piggott & Co., Limited,**
BIRMINGHAM. 2530
See Advertisement last week, page 13.

**Spencer-Hopwood & Kirke**
PATENT BOILERS *See Page 53, Feb 13.* 1994
Sole Makers: SPENCER-BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

**Tank Locomotives.**
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 2572

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**Hammers, Presses, Furnaces,**
COVENTRY. 610

**Invincible Gauge Glasses.**
*BUTTERWORTH BROS., Ltd.,*
*Newton Heath Glass Works,*
*Manchester.* Od 9753

**Electric Cranes.**
1357
S. H. HEYWOOD & CO., LTD., REDDISH.

**P. & W. MacLellan, Ltd.,**
CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c
Chief Offices: 129, Trongate, Glasgow. Od 8547
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**Fuller, Horsey, Sons & Cassell,**
SPECIALISTS in the SALE AND VALUATION of PLANT AND MACHINERY and ENGINEERING WORKS,
11, BILLITER SQUARE, E.C.3. 1834

Iron and Steel
**Tubes and Fittings.**
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2257
**The Scottish Tube Co., Ltd.**
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement, page 33, Feb. 13.

**YARROW & CO. (1922), LTD., GLASGOW.**
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS.
2276

**Campbells & Hunter, Ltd.**
Gear Cutting.
Worm Wheels cut up to 13 ft. diam.
Bevel and Mitre Wheels planed up to 6 ft. 6 in. diam.
Spur Wheels cut up to 12 ft. 6 in. diam.
DOLPHIN FOUNDRY, LEEDS. 4547

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PORTSMOUTH,
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ENGINEERS & BOILER MAKERS.

THE GLASGOW ROLLING STOCK AND PLANT WORKS.
**Hurst, Nelson & Co., Ltd.,**
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON & BRASS CASTINGS.
PRESSED STEEL WORK OF ALL KINDS. Od3382
Reg. Office and Chief Works: Motherwell. London Office: 32, Great St. Helen's, Bishopsgate, E.C.3.

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*Systems*
PRESSURE AIR, STEAM
*For Boilers of all types.*
KERMODES LIMITED,
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*Naval Outfits a Speciality,*
also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
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GEAR WHEELS up to 10 ft. diameter.
FLY ROPE and SPUR DRIVING WHEELS up to 28 ft. diameter.
BRICK and CLAYWORKING MACHINERY of all kinds.
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(UP TO 35 TONS.)
1357
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**The Glasgow Railway Engineering Company,**
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MANUFACTURERS OF RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 2633

**PROPELLERS**
AND PROPULSION PROBLEMS.
Special designs only.
"Circulation Theory."
**Akimoff Propeller Company,**
PHILADELPHIA, U.S.A. 2349

**2-500 Kw., 500/550 Volt D.C.**
GENERATING SETS, Totally Enclosed, Three Crank Self-Lubricating Engine, with Complete Condensing Plant, by Allens, Pipes, Valves, Oil Separator, &c., complete.
Admirably suited for Mining or other power transmission work.
JENNINGS, West Walls, Newcastle-on-Tyne. 2462

**John Bellamy Limited**
MILLWALL, LONDON, E.
GENERAL CONSTRUCTIONAL ENGINEERS. 1216
**Boilers, Tanks & Mooring Buoys**
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

IRON & STEEL
**Tubes AND Fittings AND Steel Plates.**
**STEWARTS AND LLOYDS, Ltd.**
GLASGOW BIRMINGHAM LONDON.
See Advertisement, page 53. 2584

**Peter Brotherhood Ltd.,**
PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 49, Feb. 13.

**Govan Engine Works,**
GLASGOW.
FOR SALE
IN WHOLE OR PLOTS.
GROUND extending to 42,672 square yards, and BUILDINGS thereon of Engine and Boiler Shops (lately belonging to Messrs. DUNSMUIR & JACKSON, Ltd.), equipped with Overhead Travelling Cranes up to 60 tons.
For particulars apply—
WEARING & MARTIN, Writers, 180, Hope Street, Glasgow.
2547

**E. J. Davis, M.I.Mech.E.,** Gas Engines Inspected. Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising London." —Great Eastern Road, Stratford, E. 15. 1794

**Electric Transporters.**
1357
S. H. HEYWOOD & CO., LTD., REDDISH.

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London Office: 101, LEADENHALL ST., E.C.3.
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Branch Office and Depot: 14, SNOW HILL, BIRMINGHAM. 'Phone: Central 2775.
Makers of
Evaporating and Distilling Plants.
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Feed Water Heaters. Evaporators.
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Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers, &c., &c. 2327

TRADE "SUMMIT" MARK.
**Slitting Saws**
AND SCREW SLOTTING CUTTERS.
JOSEPH THOMPSON (Sheffield) LTD., Townhead Street Engineering Works, SHEFFIELD. 2677

Telegrams: "Epa," London.
Telephone: 7424 Central.
**E. P. Alexander & Son.**
CHARTERED PATENT AGENTS,
306, High Holborn, London, W.C.1. 585
PATENTS. DESIGNS. TRADE MARKS.

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ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS,
CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, STEAM and GAS KETTLES } Row's PATENTS.
Morrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

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LAND AND MARINE
YARROW BOILERS.
2277

**Matthew Paul & Co., Ltd.,**
LEVENFORD WORKS, Dumbarton. 2212
See Full Page Advt., page 56, Jan. 30.

**Forgings.**
**Walter Somers, Limited,**
HALESOWEN. 7116

**Taylor & Challen Presses**
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works and Showrooms: BIRMINGHAM.
See Advert., page 10, Jan. 30. 8195

**Head, Wrightson & Co.,**
LIMITED
See Advertisement page 58. 2402

**Railway Switches and Crossings.**
T. SUMMERSON & SONS, LIMITED, DARLINGTON. 2006

**Polished Zinc and Copper**
PLATES.
In gauges from 8—18 and sizes up to 40 by 20 in.
Guaranteed flat, of Uniform thickness, and Highly Polished.
PRINTERS' PLATES LTD., 2515
11 and 12, Salisbury Square, London, E.C. 4.

**Locomotive Traversers**
(ELECTRIC). 1357
S. H. HEYWOOD & CO., LTD., REDDISH.

**New 300 & 500 B.HP. M.A.N.**
STATIONARY DIESEL ENGINES with accessories, as delivered from the makers under Peace Treaty; also Dynamos for same. All spare parts in stock.—HICK-DIESEL OIL ENGINES LTD., 70, Queen Victoria Street, E.C. 4. 2627

**For Your Repairs or any**
SPECIAL MACHINERY, try
THOMAS HUNT & SONS,
Albion Ironworks,
Bridge Road West, Battersea, S.W.11.
Est. 1854. 2703

**Rosser and Russell, Ltd.,**
MECHANICAL ENGINEERS,
QUEEN'S WHARF, HAMMERSMITH, W.
Undertake SPECIAL MACHINE WORK of any description.
WELL EQUIPPED SHOP.
LATHE WORK up to 10 ft. diameter.
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(Established 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS
MAKERS of WHEELS and AXLES of all kinds.
Chief Offices and Works:
WISHAW, SCOTLAND.
London Office: Od 8353
10, IDDESLEIGH HOUSE, WESTMINSTER, S.W.1.

## The Manchester Steam Users ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by SIR WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Worshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 2005

## Royal Show, Chester.

JULY 7th to 11th, 1925.

EXHIBITION OF IMPLEMENTS, &c.

The Regulations and Forms of Application for Space are now ready.

Applications must be made by FRIDAY, MARCH 20th, 1925.

Live Stock entries close on MAY 1st; Produce, Forestry and Horticultural Exhibitions on MAY 20th; Poultry on MAY 30th; Dogs on JUNE 19th; Competitions for Plantations, Home Nurseries, Orchards and Fruit Plantations on MAY 1st.

T. B. TURNER, Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND,
16, Bedford Square, London, W.C.1. H 227

THE SOUTH WALES INSTITUTE OF ENGINEERS.

## Engineering Exhibition.

IN THE DRILL HALL,
Richardson Street,
SWANSEA.

Under the auspices of
THE SOUTH WALES INSTITUTE OF ENGINEERS.

From THURSDAY, AUGUST 6th,
to
SATURDAY, AUGUST 15th, 1925
(both dates inclusive).
Open each day from Two p.m. to Eight p.m.

The Council of THE SOUTH WALES INSTITUTE OF ENGINEERS invite
APPLICATIONS FOR SPACE
in the above Exhibition. The Drill Hall has been booked from August 1st to August 22nd, 1925, so as to allow Exhibitors sufficient time for erection and dismantling of exhibits.

The Council desire the Exhibition to be as comprehensive as possible, and to include all kinds of machinery and plant used at works and collieries in the neighbourhood of Swansea, covering the many and varied industries of the district; such as Coal, Steel, Iron, Copper, Nickel, Zinc, Spelter, Tinplates and Galvanising; also Docks, Flour Mills, Railways, etc., as well as General Engineering.

Forms of Application for Space, Ground Plan, Schedule of Exhibits, etc., will be forwarded on application to

MARTIN PRICE, Secretary.
The South Wales Institute of Engineers,
Park Place, Cardiff. H 243

## Correspondence Courses for

Inst. Civil Engrs., Inst. Mech., London Univ. (Matric., Inter., B.Sc.), Inst. M. & Cy. E., and ALL ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng. London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successful Students. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to S/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 2689

## Draughtsmen, before

Negotiating with Government Departments in connection with any post, please communicate with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 98, St. George's Square, London, S.W.1. G 788

## Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in the lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 77, Millgate Building, Manchester. 3676


## TENDERS.

HOPPER BARGE.

THE TRUSTEES OF SHOREHAM HARBOUR invite

### Tenders for the Supply and

DELIVERY of a suitable New WOOD HOPPER BARGE, capable of carrying about 200 tons of Dredged material. Full particulars, including plans, specifications and price, to be sent to the undersigned on or before the 28th day of February, inst.

The Trustees do not bind themselves to accept the lowest or any Tender.

C. BAGULEY, Clerk to the Trustees.

Harbour Offices, Southwick, Brighton.
17th February, 1925. H 270

G. R.

H.M. NAVAL BASE, PORTLAND.

### For Sale by Tender :—

SECOND-HAND PLANT, comprising 5-ton Steam Derrick Crane (Butters). 10 HP. Portable Steam Engine. 2 No. Steam Locomotives, 4 ft. 8½ in. gauge (Bagnall). Pipe Screwing Machine. Railway Material, and Jubilee Wagons.

Steel Motor Lighter, length 111 ft., carrying capacity 70 tons, driven by Campbell Vertical Marine Paraffin Engine, complete with tools, spare cylinder and other fittings, and 268 gallons of oil fuel.

Miscellaneous Stores, consisting of Nails, Cast and Wrought Iron Piping, Steel Bar, some Scrap Iron and Steel and other old material, etc., etc.

Full particulars, giving Conditions of Sale and Form of Tender, may be obtained on application to :—
THE OFFICER IN CHARGE OF WORKS,
H.M. Naval Base,
Portland. H 259

URBAN DISTRICT COUNCIL OF HAVANT (Hants).

EXTENSION OF MAIN DRAINAGE WORKS OF HAVANT.
UNEMPLOYMENT RELIEF WORKS.
General Contract No. 2.

The Urban District Council of Havant invite

### Tenders from Responsible

and Experienced Contractors for the CONSTRUCTION of the WORKS, which comprise Stoneware and Cast Iron Sewers, Brick, Concrete and Cast Iron Manholes, Cast Iron Rising Main, Underground Pumping Station, Pumping Plant, etc., and other incidental works.

A copy of the Specification may be seen and Form of Tender and Bills of Quantities may be obtained on application, in writing, to Major T. J. MOSS-FLOWER, Chartered Civil Engineer, 28, Victoria Street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol Office, on and after the 24th February, 1925, on deposit of a £5 Bank of England Note, which will be refunded provided a *bona fide* Tender be received and is not withdrawn before the sealing by the Council of one of the Tenders, and provided also that all documents supplied be returned to the Engineer. On production of a receipt for the deposit, persons tendering may inspect the plans at Havant on a day and at a time and place which will be communicated to them.

The Contractor carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the Contract.

Sealed Tenders, endorsed "Tender for Havant Main Drainage Extension, General Contract No. 2," are to be delivered at the Council Offices, not later than Noon, on 14th March, 1925.

The lowest or any Tender will not necessarily be accepted, and the carrying out of the work is subject to the approval of the Ministry of Health and the Unemployment Grants Committee.

Dated this 17th day of February, 1925.

(By Order),
B. R. LONGCROFT, Solicitor, and Clerk to the Council.

Council Offices, Havant, Hants. H 247

BILSTON URBAN DISTRICT COUNCIL.

NEW BRATCH WATER SCHEME.

CONTRACT No. 1.

PUMPING INSTALLATION.

The COUNCIL invite

### Tenders for the Supply,

DELIVERY and ERECTION at the Bratch Pumping Station, Wombourn, Staffordshire, of TWO PUMPING UNITS, complete with Crane, Tanks, Electric Lighting Plant and all Works in connection therewith, and for the MAINTENANCE of the whole in thorough Repair for Twelve Calendar Months from the certified completion thereof.

The Pumps to be of the Vertical Spindle and Horizontal CENTRIFUGAL Types, driven by OIL ENGINES.

The general lay-out is designed for Vertical Oil Engines, but Contractors may submit Tenders and Schemes for Horizontal Oil Engines driving the above types of pumps.

Copies of the Conditions, Specification, General Drawings and Form of Tender may be obtained on application to the UNDERSIGNED. The application must be accompanied by the sum of £5, which will be refunded on return of the Documents within seven days or after the receipt of a *bona fide* Tender and the Documents required.

Each Tender must be accompanied by Drawings and Detailed Specifications.

Facilities for inspecting the Site and general information can be obtained on application to Mr. EDGAR WILLAN, the Engineer and Surveyor to the Council, Town Hall, Bilston.

Tenders are to be sent in on the Form supplied, and with the annexed documents must be enclosed in a sealed cover marked "Tender for New Pumping Plant at the Bratch," addressed to and reaching the Undersigned not later than Ten a.m., on Thursday, the 26th of March, 1925.

The Council do not bind themselves to accept the lowest or any Tender.

JOSEPH L. ARLIDGE, Clerk and Solicitor of the Council.

Town Hall, Bilston.
February 14th, 1925. H 245

## TENDERS.

THE COMMISSIONERS OF HIS MAJESTY'S WORKS, etc., are prepared to receive

### Tenders before Eleven

a.m. on Wednesday, 4th March, 1925, for the Supply of VALVES, GLAND COCKS, etc.

Forms for Tender, etc., may be obtained on application to the CONTROLLER OF SUPPLIES, H.M. Office of Works, etc., King Charles Street, Westminster, London, S.W.1. H 253

The SUBSCRIBERS are prepared to receive

### Offers for an Up-to-date

ENGINEERING BUSINESS undertaking Ships' Auxiliary and General Engineering Work. Established over 50 years. Sound connection with a fair amount of work on hand. Contractors to the Admiralty. Further particulars from Messrs. WALTER & W. B. GALBRAITH C.A., 87, St. Vincent Street, Glasgow, or from the Subscribers. Highest or any offer not necessarily accepted.

WILSON, CALDWELL & TAIT.
79, West Regent Street, Glasgow. H 246

THE DIRECTOR-GENERAL, INDIA STORE DEPARTMENT, Branch No. 16, Belvedere Road, Lambeth, S.E. 1, invites

### Tenders for :—

1. ACCUMULATORS FOR TRAIN LIGHTING.
2. BOILERS FOR LOCOMOTIVES.
3. LANCASHIRE OR CORNISH BOILERS.
4. BRIDGEWORK.

Tenders due on the 3rd March, 1925, for No. 1, on the 10th March, 1925, for No. 2, on the 17th March, 1925, for No. 3, and at 10.30 a.m., on the 26th March, 1925, for No. 4.

Tender Forms obtainable from above. H 288

STEAM NAVVY FOR SALE.

### Tenders are about to be

Invited for the purchase of a RUSTON STEAM NAVVY at Longmoor Camp, Hants., particulars of which are as follows :—
Bucket capacity 2¼ cu. yards.
Rail Gauge 4 ft. 8½ in.
Working Gauge 9 ft. 3 in.
Wheelbase 9 ft. 11 in.
Total weight about 60 tons.

Forms of Tender can be obtained on application to THE DIRECTOR OF ARMY CONTRACTS (D.C. Sales), Caxton House West, Tothill Street, S.W. 1. H 289

METROPOLITAN WATER BOARD.

PROVISION OF 5 TON STEAM CRANE—BATTERSEA.

The Metropolitan Water Board invite

### Tenders for the Supply, Test-

ING and Setting to Work of a STEAM DRIVEN LOCOMOTIVE SHUNTING JIB CRANE of 5 tons capacity at their Works in Kirtling Street, Battersea Park Road, S.W.

Tenders must be made on the official forms which may be obtained on and after Thursday, 19th February, 1925, from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery Avenue, E.C.1. by personal application (Room 156), or upon forwarding a stamped addressed brief envelope.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk, Metropolitan Water Board, New River Head, 173, Rosebery Avenue, E.C.1," and endorsed "Tender for Crane," must be delivered at the Offices of the Board (Room 129) not later than 11 a.m., on Tuesday, 3rd March, 1925.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER, Clerk of the Board.

Offices of the Board, 173, Rosebery Avenue, E.C.1.
17th February, 1925. H 278

TYNE IMPROVEMENT COMMISSION.

ELECTRIC MOTORS AND ACCESSORIES.

The Tyne Improvement Commissioners are prepared to receive

### Tenders for the Supply and

DELIVERY OF ONE 20 HP. AND THREE 3 HP. D.C. ELECTRIC MOTORS for their No. 3 Staith, Whitehill Point, North Shields.

Copies of the Form of Tender and Specification may be obtained on application to the undersigned.

Tenders in sealed envelopes, endorsed on the cover "Tender for Electric Motors and Accessories," must be delivered at the undermentioned offices, addressed to "The Chairman of the Docks Committee, Tyne Improvement Commission," not later than Noon, on Saturday, the 28th day of February, 1925.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order, ALBERT BLACKLOCK, Secretary.

Tyne Improvement Commission Offices, Bewick Street, Newcastle-on-Tyne.
17th February, 1925. H 257

BOROUGH OF BEDFORD.

DISPOSAL OF PLANT.

The Corporation invite

### Tenders for the Purchase of

the following :—
(A) Three Lancashire Boilers, 30 ft. by 8 ft., with mountings and Mechanical Stokers.
(B) Three 30-ton steel bunkers.
(C) Steam driven induced draught fan.
(D) Hall Feed Pump.
(E) One Brick Chimney Stack, 130 ft. by 4 ft. (internal).

Particulars and Form of Tender may be obtained on application to the Borough Electrical Engineer, Prebend Street, Bedford, at which address the plant may be inspected.

Tenders endorsed "Disposal of Plant" and addressed to the Chairman of the Electricity Committee, Prebend Street, Bedford, must be delivered on or before Noon, on February 28th, 1925.

The Corporation do not bind themselves to accept the highest or any Tender.

H. DARLOW, Town Clerk.

Town Hall, Bedford.
February, 1925. H 269

CITY OF LIVERPOOL.

WATER ENGINEER'S DEPARTMENT.

CONTRACTS FOR THE SUPPLY OF MATERIALS, &c.

The Corporation are prepared to receive

### Tenders Covering the Period

of Twelve Months ending 31st March, 1926, in respect of the Materials, &c., set out in the undermentioned Schedules, viz :—

1. BRASS CASTINGS AND FITTINGS.
2. CARTAGE.
3. LEAD PIPE.
4. CAST IRON PIPES.
5. MISCELLANEOUS IRON PIPES AND CASTINGS.
6. SLUICE VALVES.

Separate Tender Forms, including Specification and Schedule, for any of the above items will be forwarded upon receipt of application in writing to the Water Engineer, Alexandra Buildings, 55, Dale Street, Liverpool.

Duplicate Forms of Tender for record purposes will not be supplied.

Tenders must be sealed and enclosed in the official envelopes provided, endorsed in accordance with the instructions in the Form of Tender, and FORWARDED THROUGH THE POST, addressed to "The Town Clerk, Municipal Buildings, Liverpool," so as to be delivered not later than Ten o'clock a.m., on Tuesday, the 3rd March, 1925.

WALTER MOON, Town Clerk. H 293

The DUBLIN BOROUGH COMMISSIONERS hereby invite

### Tenders for the Supply of

ROAD MATERIALS for the half year commencing on 1st April, 1925, as follows :—
1,800 Tons approx. 2in. Broken Green Whinstone or Granite.
1,400 Tons approx. 1in. Broken Green Whinstone or Granite.
3,500 Tons approx. Chippings.
500 Tons approx. Blinding.
1,800 Tons approx. Tarred Macadam.
600 Tons approx. Tarred Chippings.
5,000 Tons approx. Sand (for Street sanding, sheet asphalte, etc.).
4,000 Tons approx. Concrete Aggregate (coarse and fine crushed).
800 Tons approx. Portland Cement.

Specifications, Forms of Tender and Conditions of Contract may be obtained at the Offices of the City Engineer, 28, Castle Street.

Sealed Tenders, endorsed "Tender for....." and addressed to the Dublin Borough Commissioners, City Hall, must be delivered not later than 12 o'clock Noon on Monday, 16th March, 1925.

By Order, JOHN J. MURPHY, Town Clerk.
17th February, 1925. H 290

## APPOINTMENTS OPEN.

AUCKLAND UNIVERSITY COLLEGE, NEW ZEALAND.

### Applications are Invited

for the POSITION of LECTURER in CIVIL ENGINEERING. Salary £500 per annum. Full particulars obtainable from the HIGH COMMISSIONER FOR NEW ZEALAND, 415, Strand, London, W.C. 2, by whom completed applications will be received up to and including the 31st March, 1925. H 266

INDIAN SERVICE OF ENGINEERS.

THE SECRETARY OF STATE FOR INDIA IN COUNCIL will, in 1925, appoint

### Eight Assistant Execu-

TIVE ENGINEERS for this Service if so many suitable candidates present themselves.

Every candidate must be a European British subject, and must be not less than 21 years and not more than 24 years of age on 1st August, 1925

They must either (1) have obtained one of certain recognised University degrees or other distinctions in Engineering, or (2) have passed sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such examination, or (3) produce the required evidence that they are otherwise eligible under the Regulations. They must in addition have had at least one full year's practical experience of Civil Engineering under a qualified Civil Engineer at the time when they appear before the Selection Committee.

Applications from candidates must reach the India Office not later than 1st April. Printed forms, together with information regarding the conditions of appointment, may now be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W.1. H 234

RESEARCH DEPARTMENT.
ROYAL ARSENAL, WOOLWICH.

DIRECTORATE OF METALLURGICAL RESEARCH.
ASSISTANT II (Temporary).

### Required, One Tem-

PORARY ASSISTANT, Grade II. Should be graduate with University training in Metallurgy and some years experience of metallurgical research. Initial salary £250 and bonus. Total emoluments at present £369 5s. Leave at the rate of 36 days per annum.

JUNIOR ASSISTANT (Temporary).

Required, Metallurgist. Should be a graduate who has received a University training in Metallurgy. Initial salary £160 and bonus. Total emoluments at present £253 5s. Annual leave 24 days.

Some years experience in metallurgical analysis would be an additional qualification for either of the above posts. Ex-service men, if suitably qualified, will be preferred for both appointments.

Applications in writing, accompanied by copies of not more than three testimonials, should be made to the
CHIEF SUPERINTENDENT, Research Department, Royal Arsenal, Woolwich, S.E.18, from whom conditions of employment may be obtained. H 284

# A NEW SEPARATELY EXCITED SYNCHRONOUS INDUCTION MOTOR.

By VAL. A. FYNN, M.I.E.E., Fel. A.I.E.E.

THE difficulties confronting the designer of separately excited synchronous induction motors and the various ways in which these have been handled hitherto are here discussed and analysed with special reference to their influence on the stability, the weight efficiency and the conversion efficiency of such machines. The writer's methods of overcoming the difficulties in question are then outlined and compared with those now in use. The new separately-excited synchronous induction motors devised by the writer are then described in detail and their mode of operation at starting, during the synchronising period, at synchronous speed and under overload conditions is fully analyzed with the help of a number of diagrams.

Hitherto the synchronising torque in such machines has always been an alternating one with equal positive and negative maxima and the motors were not self-regulating at synchronism. The writer has replaced the alternating synchronising torque with a unidirectional and pulsating or with a unidirectional and constant synchronising torque, and has made the machine self-regulating in so far as its unidirectional excitation at synchronism is concerned. These improvements result in considerable saving of active material and in other important advantages.

*Introduction.*—Synchronous induction motors have lately become of considerable commercial importance and are being more and more widely used. The smaller motors are usually of the self-excited type, while the larger machines are all separately excited. Synchronous induction motors are mostly made in the larger sizes and the separately-excited type is, therefore, the more interesting. In a paper read at the Birmingham (Alabama) Spring Convention of the A.I.E.E., on April 9, 1924, the writer discussed the self-excited type and described one of the forms of this type devised by him some years ago; in the present article, it is proposed to deal with a new type of separately-excited synchronous induction motor also devised by the writer.

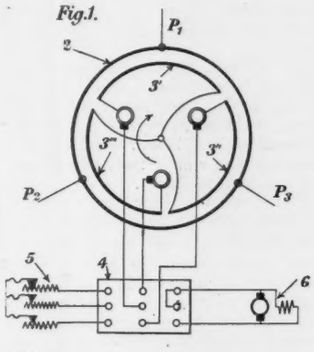
So far as is known, no radical departures have been made so far from the lines followed by E. Danielson in 1901, although the results now being obtained are much superior to those secured by the originator of this type of machine. This improved performance is believed to be due to changes in design constants rather than to the use of different principles or to radical changes in design. This type of machine is usually wound for use on a polyphase supply. It can be built for use on single-phase circuits, but this involves, among other things, special arrangements for starting and is not believed to be of practical importance at the present time. In the following matter, polyphase motors only will be dealt with.

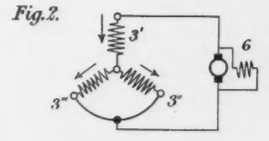
The major problems connected with the design of a general purpose polyphase synchronous induction motor are four-fold: (1) Starting and accelerating; (2) synchronising; (3) control of the power factor in normal or synchronous operation; (4) conversion efficiency and weight efficiency.

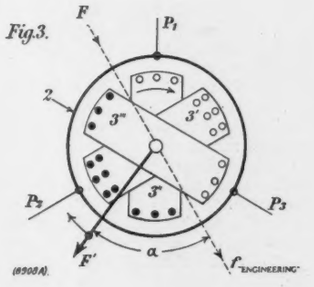
(1) To secure the best starting and accelerating it is, of course, best to fall back on the induction motor characteristics of this type and build these machines without defined polar projections, with air-gaps of the same length as those of corresponding polyphase asychronous induction motors of usual design and with a polyphase arrangement of windings on the secondary. Whether the machine is started like a squirrel-cage motor or provision is made for inserting resistances in the secondary at starting, depends on the nature of the service for which the motor is intended. While it is simple enough to carry out this programme, yet its provisions unfortunately clash with other requirements, as will presently appear.

It has usually been found necessary to design synchronous induction motors with much longer air-gaps than those used in corresponding ordinary induction motors. The longer air-gap increases the excitation and the leakage. By using open, or nearly-open, slots the leakage can be somewhat reduced, but only at the expense of a further increase in excitation. The increased leakage results in a reduction of the maximum available torque at starting and in a decrease of torque per ampere. But even under these unfavourable conditions, the starting performance remains acceptable and sufficient torque is available for most cases.

(2) In the neighbourhood of synchronism, the induction motor torque diminishes very rapidly with increasing speed and actually becomes zero at synchronism, for this reason it cannot possibly synchronise the motor. The hysteresis torque is insignificant in a motor without defined polar projections. In the Danielson machine, synchronisation is brought about by producing unidirectional ampere-turns in the closed windings on the secondary, which results in the generation of an alternating synchronising, or "pull in," torque of slip frequency having equal positive and negative maxima.



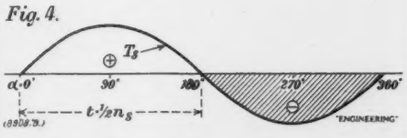




Fig. 1 diagrammatically illustrates a two-pole, three-phase Danielson motor, 2 being the primary stator winding, 3′, 3″, 3‴ the secondary three-phase rotor windings connected to sliprings, 4 a three-pole two-way switch, 5 the starting resistances, and 6 the source of unidirectional current. The machine is started by throwing switch 4 to the left and reducing the resistances 5 to zero in one or more steps. When near its highest speed as an asynchronous motor, switch 4 is thrown to the right, establishing the secondary connections shown in Fig. 2. To show clearly how the synchronising torque is produced in the Danielson motor, the three-phase rotor winding of Fig. 2 has been drawn in Fig. 3 in the form of three belts 3′, 3″, 3‴, movably located within the primary winding 2. The direction of the unidirectional current in the active parts of the belts is indicated by dots and circles. The dots indicate current directed down through the plane of the paper and the circles denote the opposite direction of current. The ampere turns due to this unidirectional current produce a unidirectional magnetisation F, the axis $f$ of which is fixed with relation to the secondary windings as long as the current distribution shown in Fig. 2 is not changed. Under normal operating conditions, F does not change its axis or its direction relatively to the secondary element of the motor.

At sub-synchronous speeds, the primary 2 produces a revolving flux F′ rotating synchronously and, say, clockwise. Because the secondary "slips" there is a difference in speed between $f$ and F′. This difference is equal to the slip speed and is very small near synchronism. It decreases with rising motor speed and generates decreasingly small induction-motor-torque producing currents in the secondary which are, however, not looked upon as part of what is here termed the synchronising torque. The latter is that which results from the interaction of the revolving flux F′ and the secondary unidirectional ampere turns magnetising along the axis $f$. Since these ampere turns are constant and F′ moves relatively to $f$, this synchronising torque will always be proportional to that component of F′ which is at right angles to $f$. Beginning to count the displacement $\alpha$ of F′ relatively to F at the instant when F′ coincides with and is of same direction as F, we find that for $\alpha = 0$ the synchronising torque is also zero, because there is then no component of F′ at right angles to $f$. As F′ continues on its way, its component F′ sin $\alpha$, at right angles to $f$, enters the rotor on the side which carries upwardly-directed current producing a clockwise, and here positive, torque which reaches a maximum when $\alpha = 90$ deg. For $\alpha = 180$ deg. the synchronising torque is again zero. A further relative movement causes the component F′ sin $\alpha$ of the revolving flux to enter the rotor on the side which carries downwardly directed unidirectional current, thus producing a counter-clockwise, and here negative, torque which reaches a maximum when $\alpha = 270$ deg. Since F′ moves with slip speed with reference to $f$ and F is constant, it is clear that the Danielson synchronising torque is an alternating torque of slip frequency with equal positive and negative maxima. The curve $T_s$ of Fig. 4 shows the configuration of this torque. The time $t$ during which this torque is positive is $\frac{1}{2n_s}$, where $n_s$ is the slip frequency, and equals the time during which it is negative.

The usual simplifying assumptions are made throughout this paper that all fluxes have sine distribution and all voltages and currents vary according to the sine law.

The maximum amplitude of the Danielson synchronising torque depends on the magnitude of the revolving flux F′, which is fixed by the magnitude of the voltage at the terminals of the primary winding 2, and on the number of effective unidirectional ampere turns on the secondary. The slip speed only affects the periodicity of this torque.

It is believed that all separately-excited motors built to date exhibit this same alternating torque with equal negative and positive maxima. Such a torque, if of sufficient amplitude, is able to synchronise the motor, but it is also liable to bring about hunting or surging. The first positive wave after insertion of the source of unidirectional current accelerates the secondary, reducing the induction motor torque; if it fails to synchronise the motor the negative wave which follows it decelerates the secondary to a point where the now increasing induction-motor torque not only equals and opposes the then prevailing negative synchronising torque but exceeds it sufficiently to take care of the load. This means quite a drop in the speed of the secondary, and luckily also an increase in the frequency of the synchronising torque. The following positive wave of the synchronising torque again accelerates the secondary with the assistance of the induction motor torque which, however, becomes insignificant as soon as synchronism is closely approached. This play continues until the load is sufficiently reduced to permit of synchronisation. If a negative wave of the synchronising torque happens to precede the first positive wave, hunting is even more likely to be initiated. The greater the amplitude of the synchronising torque the greater the danger of hunting until the amplitude reaches a value which will quite positively synchronise the motor under

existing load conditions even if the first synchronising torque wave is negative.

A synchronous-induction motor with standard induction-motor air gap and a unidirectional excitation corresponding to about unity power factor at full load will not synchronise with anything like full load torque. One way to increase the synchronising torque is temporarily to raise the terminal voltage and another is to increase the unidirectional ampere-turns on the secondary. Because of the complicated manipulations it entails, if for no other reasons, it is usually not practical to raise the terminal voltage temporarily above the normal. The unidirectional ampere-turns can be increased by temporarily raising the exciting voltage, by building the motor with a longer air-gap or by normally working the iron at higher magnetic densities. A temporary increase in excitation complicates the manipulation but is within practical politics. Permanently working the iron at higher densities is only permissible in machines, in which the iron is not already used to best advantage. The usual way out of the difficulty is a lengthening of the air-gap, coupled with as high densities as other considerations permit. A longer air-gap is found advantageous for other reasons as will presently appear, but carries with it distinct disadvantages to which reference will also be made later.

In his A.I.E.E. Birmingham paper, the writer attacked the problem from a totally different angle, and disclosed means whereby the usual alternating synchronising torque of a self-excited synchronous induction motor could be replaced by a substantially unidirectional and pulsating synchronising torque. In this article it will be shown how a unidirectional and pulsating and even a unidirectional and constant synchronising torque can be produced in a separately excited synchronous induction motor.

(3) After the machine has been brought into synchronism, the synchronously revolving field comes under the control of the unidirectional excitation on the secondary, and appears as the resultant of this magnetisation and of the alternating current armature reaction, which is, however, always unidirectional in so far as the unidirectional excitation on the secondary is concerned. If the secondary excitation is kept constant, the power factor will vary with varying load, the motor taking at each load a primary current of such phase and magnitude as will produce an armature reaction which, when combined with the constant secondary excitation, will yield a resultant revolving field of the necessary phase and magnitude.

If the machine is built with an air-gap of standard induction motor length, the ampere-turns necessary to produce about unity power factor at maximum load, or only at full load, will be very greatly in excess of those needed for the same purpose at no load. If this maximum load or the full load excitation is kept constant, then the motor takes an unduly large leading current component at no load. If the excitation is reduced to that required at no load and kept constant, the maximum synchronous torque diminishes to a prohibitive extent.

One way out of the difficulty is to provide external automatic regulating apparatus adapted so to control the unidirectional excitation as to cause the motor to operate at unity power factor, or thereabouts, at all loads. Theoretically, this solution is perfect; practically, it adds to the cost and complication of the installation but is nevertheless acceptable. Another way is to improve the inherent regulating properties of the machine. This can be done by reducing the ratio of maximum to minimum exciting ampere-turns. Decreasing the maximum ampere-turns to reduce the said ratio means a serious reduction in output and cannot be considered. Increasing the minimum or no-load ampere-turns for the same purpose can be best achieved by lengthening the air-gap, but the total so-called exciting ampere turns are thereby increased. This expedient is nevertheless often resorted to, particularly since it also increases the amplitude of the synchronising torque.

A synchronous induction motor with lengthened air-gap may be commercially operated with constant excitation. The inherent power factor control of such motors is fair, but at loads below the normal and at no load they still take a very considerable leading-current component. This is without consequence in the case of motors which operate at very nearly full load at all times and under the present generally poor power factor conditions it is acceptable in motors which frequently handle fractions of their full load, but the fact must not be lost sight of that a leading current produces just as much loss in the distributing system as a corresponding lagging current. In the generators it produces just a little less loss because the excitation necessary for a given leading current is less than that for the corresponding lagging one. This difference is insignificant. When the power factor situation as a whole has been improved, motors taking a leading current will be just as objectionable as those requiring a lagging current component. Furthermore, whenever the excitation is kept constant, the efficiency suffers at all loads except at that for which the said excitation yields about unity power factor.

In his A.I.E.E. Birmingham paper the writer showed how a very much closer inherent power-factor regulation, and therefore also a higher efficiency, could be incorporated with self-excited synchronous motors; below, means will be indicated for accomplishing similar results in the separately-excited synchronous motor.

(4) Conversion efficiency and weight efficiency are so closely related that they must be considered together if a correct impression is to be obtained.

In an asynchronous motor the excitation is constant and is supplied by the lagging current component in the primary. The armature reaction has its seat in the secondary and is at all times neutralised inductively. Exciting and neutralising losses consist of iron losses and ohmic losses, and are supplied by the source of alternating current. After the machine has been converted into a synchronous motor the exciting and the neutralising ampere-turns must be supplied by the source of unidirectional current. The exciting and neutralising ohmic losses are supplied by the "exciter," the iron exciting losses continue to be supplied by the source of alternating currents. The conversion efficiency of the exciter, of course, also enters into the calculation in the case of the separately excited machine.

It is well to note that, although it is general practice, followed in this paper, to speak of the unidirectional ampere-turns on the secondary of a synchronous motor as "exciting ampere-turns," of the corresponding current as "exciting current," and of the source of this current as "the exciter," yet the fact is that the ampere-turns in question do not provide excitation only, but part of them also oppose the armature reaction and neutralise at least part of the magnetisation produced by the said reaction. The true situation in this respect should be clearly kept in mind when analysing a synchronous induction motor. It is well to remember, moreover, that in the asynchronous machine the space distribution of the windings which carry the neutralising and the exciting ampere-turns is more effective than is the space distribution of the corresponding windings in most synchronous motors of the synchronous induction-motor type. This leads to still greater "exciting" losses in the latter.

Whenever the air-gap is lengthened, whether with a view to increasing the amplitude of the synchronising torque or for the purpose of improving the inherent regulation of the machine, the output of the exciter, and consequently the losses, are increased and the conversion efficiency of the unit decreased unless active material is added which results in a decreased weight efficiency.

Weight for weight, the conversion efficiency of a machine with an induction motor air-gap is consequently higher at all loads than that of a motor with a longer air-gap, its starting performance is as good as possible, but it requires an external automatic exciting-current regulator and has a low synchronising torque. The automatic regulator accentuates its conversion efficiency advantage at fractional loads. To increase the synchronising torque or to do away with the necessity for using an automatic regulator, it is necessary to make a sacrifice in conversion efficiency or to increase the weight of the active material, and consequently the price of the unit.

Whatever course is followed, the maximum synchronous torque is found to be less than the maximum non-synchronous torque which can be obtained if the material employed is utilised in the most approved manner in building an ordinary polyphase-induction motor. Thus, it is found that when a synchronous induction motor, with induction-motor air gap, is operated as an ordinary induction motor its maximum non-synchronous torque is greatly in excess—in fact, about twice as great—as its maximum synchronous torque. If the air gap is lengthened the asynchronous overload capacity is reduced, because of the increased leakage, while the synchronous overload capacity is increased. The discrepancy in the two overload capacities is reduced, it is true, but so are the conversion and weight efficiencies. This means that, for a like conversion efficiency, the machine with the longer air-gap is the heavier and consequently the more expensive.

In view of these conditions, the idea naturally occurs to one to use a motor with standard induction motor air-gap and automatic exciting current regulator, so rate the machine that the normal full-load torque falls some 15 to 25 per cent. below the maximum synchronous torque and utilise the asynchronous characteristic of the machine for all overloads, thus making full use of the active material and introducing, at least during overloads, the very desirable cushioning effect of the asynchronous motor. This attractive proposition is rendered hopeless by the fact that hitherto the synchronising torque in synchronous induction motors has been an alternating torque with equal positive and negative maxima. Such motors run very uneasily, if they run at all, under loads requiring a torque substantially in excess of the maximum synchronous torque and practically their rating must be based on their maximum synchronous and not on their very much higher maximum non-synchronous torque. All the necessary active material for the production of this very much greater non-synchronous torque is in the machine, and this larger torque is actually produced, but it is rendered non-available by the interference of the alternating synchronising torque. One of the worst features of an alternating synchronising torque with equal positive and negative maxima is that it reduces very materially the weight efficiency of the synchronous induction motor.

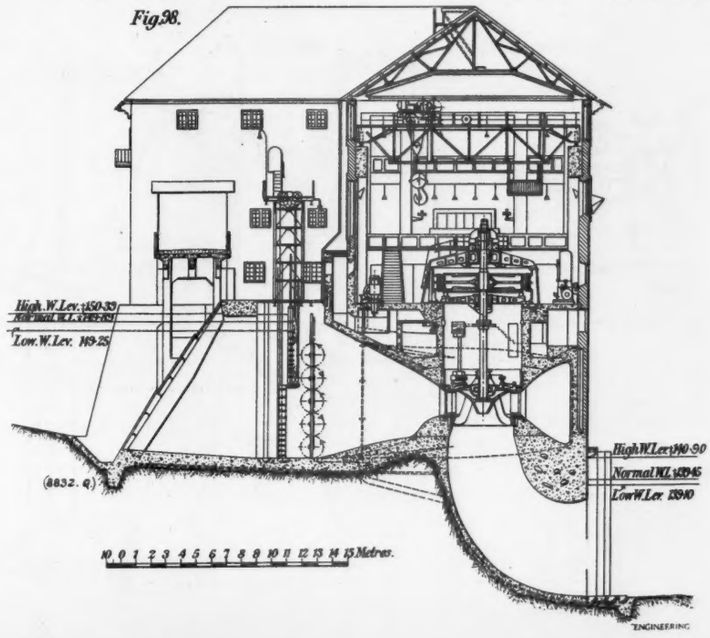
Suppose that the maximum non-synchronous torque of such a machine is twice its maximum synchronous torque, and that its synchronising torque is equal to its maximum synchronous torque, then, upon the demand for a torque in excess of the maximum synchronous the motor will fall out of step, causing the synchronising torque to reappear instantly. Because this torque is alternating and possessed of an amplitude equal to one-half of the maximum asynchronous torque, the speed will fluctuate very markedly under overload conditions, also causing the available torque to vary greatly. If the torque demand is only a little in excess of the maximum synchronous torque, there will be no torque available in excess of the demand when the synchronising torque is at its negative maximum, and when it is at its positive maximum the available torque will be three times that which is required. Without resonance effects, the speed will vary from the asynchronous break-down slip to very near synchronism. Asynchronous overload operation under such conditions is impractical, in fact, impossible.

In this article the writer intends to show how a synchronising torque can be produced of such configuration as will not interfere with asynchronous overload operation of a synchronous induction motor and will not lower the weight efficiency of such machines. In addition, means will be explained whereby the unidirectional current on the secondary of a separately excited synchronous induction motor can be automatically regulated, by means of the reactions within the machine and without the help of any external automatic or other devices of any kind, excepting the exciter, so that the power factor will be acceptable at all loads and, what is more, the motor will at no time take an excessive leading current component.

With the help of the improvements about to be

# HYDRO-ELECTRIC PLANT AT FORSHUVUDFORSEN.

Fig. 98.


High W.Lev. 150·33
Low W.Lev. 149·25
(8832. q)
High W.Lev. 190·90
Normal W.L. 189·45
Low W.Lev. 188·40
10 9 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Metres.
"ENGINEERING"

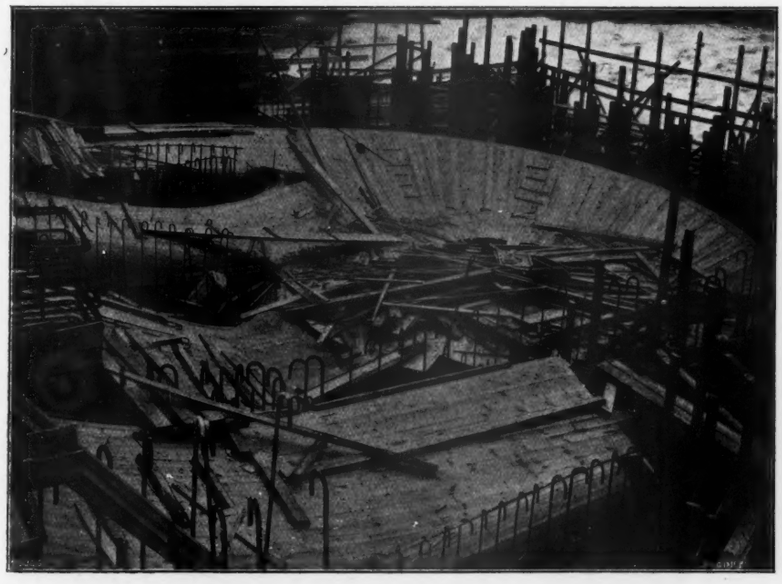


FIG. 99. FORMS FOR ONE OF THE TURBINE SCROLLS.

Fig. 100. MEAN VELOCITIES OF VERTICAL ELEMENTS OF GAUGING SECTION. TURBINE No. 2.

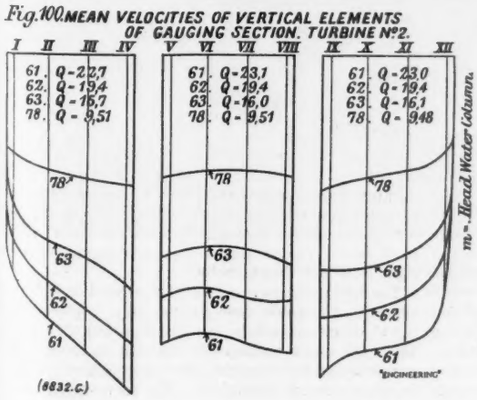
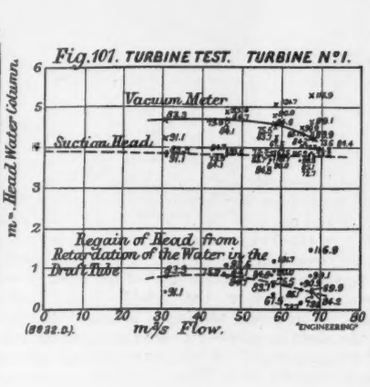



Fig. 101. TURBINE TEST. TURBINE No. 1.


Vacuum Meter.
Suction Head.
Regain of Head from Retardation of the Water in the Draft Tube
m's - Head, Water Column.
0 10 20 30 40 50 60 70 80
m/s Flow.
(8832.b).
"ENGINEERING"

described, separately excited synchronous induction motors can be built on the lines now usual for asynchronous motors and with the usual very short air gaps used in such machines. As a result, the new motor has all the starting and high overload characteristics of the best non-synchronous motors together with a synchronising torque equal to the maximum synchronous torque, about unity power factor at synchronous full load, an acceptably small leading-current component at all fractional loads, an asynchronous overload capacity equal to that of the corresponding ordinary non-synchronous motor, a weight efficiency at least equal to that of the corresponding non-synchronous motor and a somewhat lower conversion efficiency. Additional advantages are entire absence of any tendency to hunt or surge and the cushioning effect of the yielding non-synchronous motor during periods of overload.

*(To be continued.)*

## HYDRO-ELECTRIC PLANT AT FORSHUVUDFORSEN, SWEDEN.

*(Concluded from page 158.)*

THE generating units of the Forshuvudforsen installation are arranged as shown in Fig. 4, Plate I, which accompanied our issue of January 2. They have vertical shafts, with short passages, both for the intakes and draught tubes. The station has accommodation for three units. At present only two are installed. The volume of water available for each machine is in the neighbourhood of 2,470 cub. ft. per second, while the head is only low, being 33·8 ft. The vertical system lends itself admirably to such conditions, and can be arranged so as to involve comparatively small losses of head. It is possible with a good layout of scroll to supply water at a high velocity to the guide passages, so that the radial dimensions of the scroll may be reduced. This and other features tend to decrease the cost of the installation. Fig. 98 gives a cross-section of the power-station, and shows the general arrangement of the units.

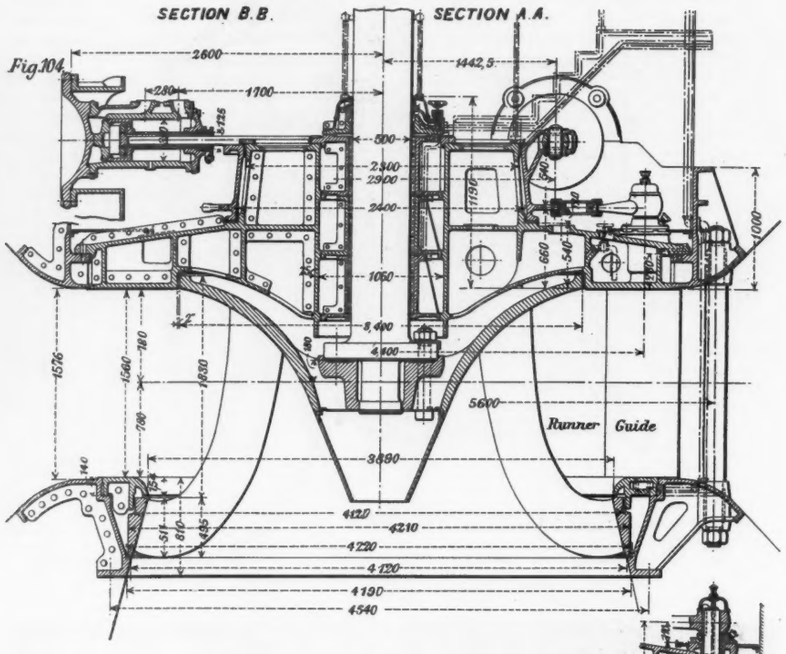
On the basis of tests of high-speed model runners and as a result of an investigation into the relative costs of machines and the question of gain of energy, the normal speed of the turbines was fixed at 83·3 r.p.m. In relation to the head, and to the quantity of water, this speed is unusually high, the specific speed of the turbine being about 400. Owing to the favourable conditions of head and water-levels, it was possible to place the turbines at such an elevation that the scroll could be made symmetrical with regard to an horizontal plane cutting through the middle of the height of the guides. This ensures the flow of water contracting very smoothly and uniformly towards the guides. The intakes are divided, it will be remembered, into three by party walls, as shown in the small scale plan, Fig. 4, in Plate I, above referred to. A view showing the wooden forms for one of the scrolls, given in Fig. 99, annexed, which also shows these three intake connections running into the body of the scroll. The distribution of flow thus obtained is very even, as is shown by the curves given in the diagram, Fig. 100, giving the velocities recorded in tests made at different gauging points across the three passages for turbine No. 2. The calculated velocities were, in fact, fairly well realised. Fig. 102, on page 218, is a view inside one of the scrolls, or volutes, showing how these are symmetrically disposed above and below the guide vanes; this point will also be clear on reference to Fig. 107, on page 219.

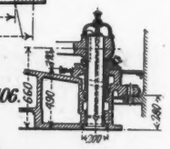
The draught-tube conditions were also favourable, the tubes being wholly contained within the substructure of the power station, the discharge in each case leaving through an opening of 516·5 sq. ft. in the down-stream wall of the building. The length of the draught-tube measured along its shortest side is no more than 26 ft. With a view to avoiding cavitation, whirling, &c., disturbing the uniform retardation of the flow in the draught-tube, smooth curves were aimed at, the convex profiles becoming more curved as the velocity decreased. Fig. 101 gives results of tests on turbine No. 1, the vacuum gauge being inserted at a point slightly below the bottom ring of the

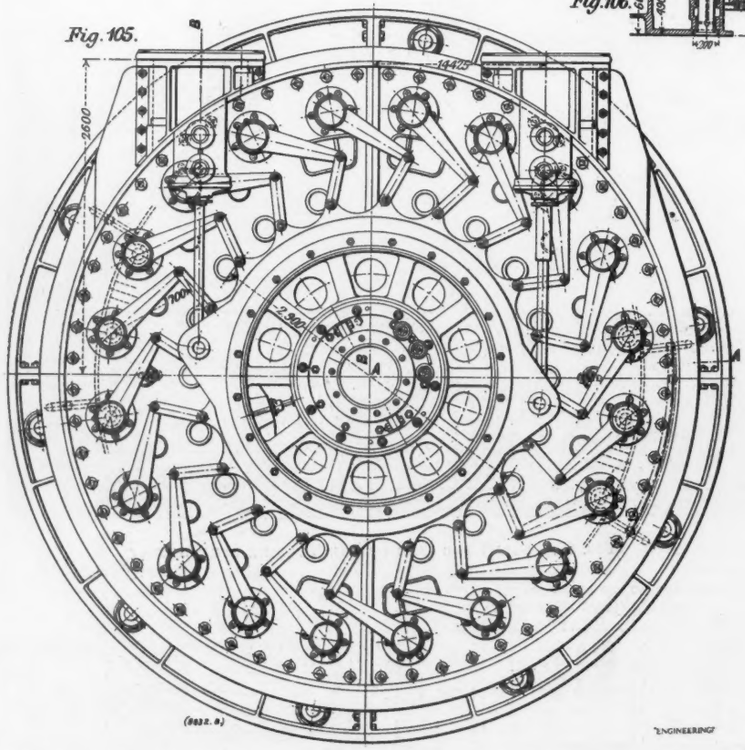
# HYDRO-ELECTRIC PLANT AT FORSHUVUDFORSEN, SWEDEN.

Fig. 102. View Inside One of the Turbine Scrolls.

Fig. 103. Runner of No. 2 Turbine.




turbine. This diagram shows the gain of head due to the retardation in the draught tube. The draught-tubes are coated with clinker in order to avoid loss by the edges and roughened surface of corroded steel plates.

The two units so far installed have been constructed by the Nydqvist and Holm Aktiebolag of Trollhättan, and the Aktiebolaget Karlstads Mekaniska Verkstad, Verkstaden, Kristinehamn, Sweden. The gates of the turbines have 20 cast-steel guide vanes coupled to the control ring by arms and links. The cover of the wheel race, and the machinery resting upon it, as well as the adjacent parts of the setting are supported by a speed ring designed to support a load of 600 tons. In the case of turbine No. 1, by Messrs. Nydqvist and Holm the speed ring stays are rolled steel columns. In the case of the No. 2 turbine they are hollow castings of oval cross section. The runners are of cast-steel, the diameters at the outlet being 4·1 and 4·0 metres respectively (13·45 and 13·12 ft.).

The No. 1 turbine runner has 13 blades and weighs about 24 tons. In the case of this runner, with a view to ensuring the utmost soundness of material, the blades were formed separately and subsequently fixed to the boss and ring. The No. 1 machine is illustrated in Figs. 104 to 107 above and on page 219. This turbine has a shaft 500 mm. (19·7 in.) in diameter. The steady bearing on the cover is of lignumvitæ. The thrust bearing is designed for a maximum load of 150 tons, of which about 115 represent the weight of the revolving parts. The thrust bearing is arranged at the top of the shaft on a spider above the generator stator. The bearing is of the Kingsbury type and make, and has a diameter of 3·77 ft. This has proved quite satisfactory in service. The bearing is enclosed in an oil tank kept supplied by means of a pump driven by gearing off the main shaft, cooling being arranged for by circulation through pipes on the top of the scroll case. The circulation system is provided with sight feed and thermometer.

The hydraulic servo-motor of the No. 1 machine, operating the guide vane control ring, is placed in the shaft pit, as will be seen in Figs. 104, 105 and 107. Oil under pressure is supplied to the servo-motor by an independent electrically driven pump on the generator room floor. The servo-motor is a two cylinder arrangement placed just above the

# HYDRO-ELECTRIC PLANT AT FORSHUVUDFORSEN, SWEDEN.

*Fig. 107.*

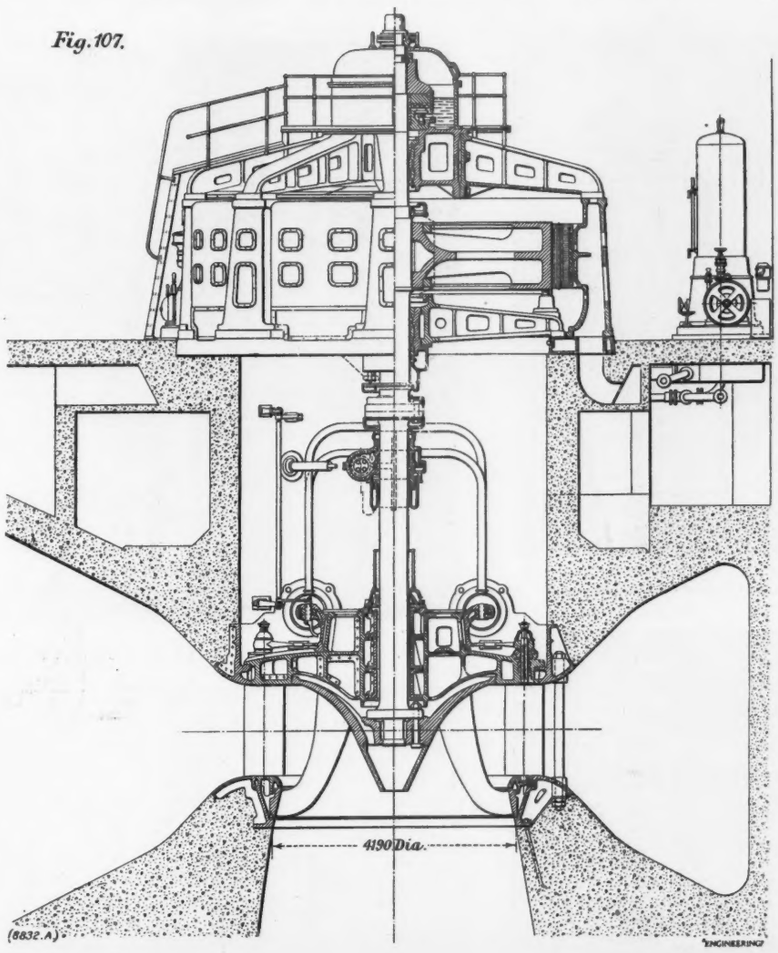



*Fig. 108.* DISCHARGE-OUTPUT (E) & EFFICIENCY (η) TURBINE No 1.

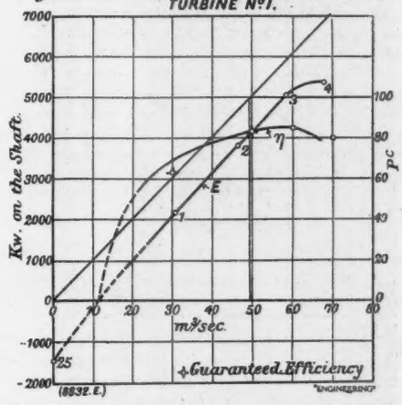
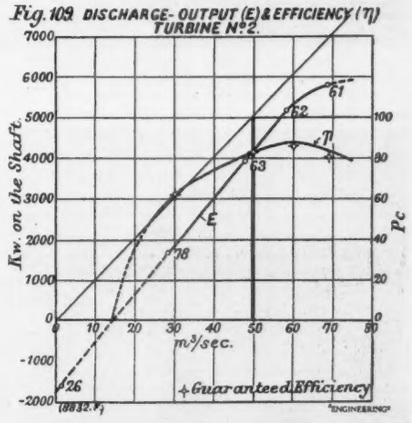



*Fig. 109* DISCHARGE-OUTPUT (E) & EFFICIENCY (η) TURBINE No 2.



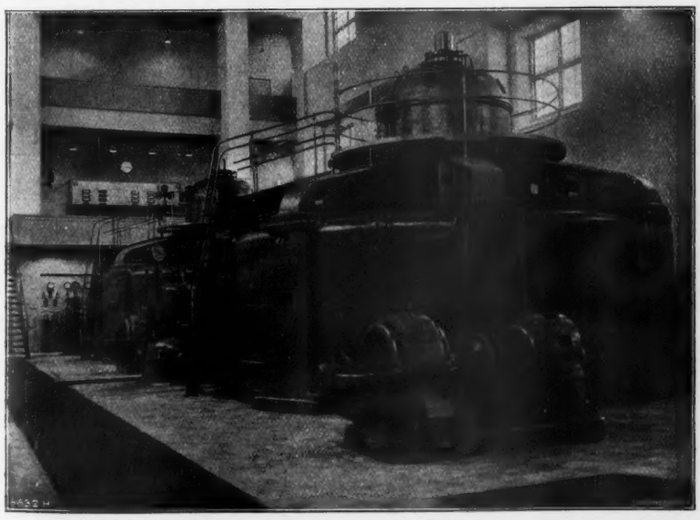



FIG. 110. INTERIOR OF GENERATOR ROOM.

FIG. 111. VIEW OF GENERATOR ROOM FROM OVERHEAD CRANE.

turbine cover, the trunk piston rods being connected direct to the control ring, as shown in Figs. 104 and 105. Fig. 106 shows the guide vane spindle and gland arrangement. Hand control is also provided. Incorporated with the governor gear there is a hand-locking gear for holding the gate ring in the shut position, an indicator showing the amount of opening of the guide vanes, and a tachometer. The governor is driven by worm gearing.

The No. 2 turbine by the Verkstaden, Kristinehamn has a runner (Fig. 103) 13·12 ft. in diameter with fourteen blades, which weighs 18·7 tons. The shaft is 17·7 in. in diameter, the steady bearing being lined with white metal and lubricated by a spur gear pump. The maximum load on the thrust bearing for which this machine is designed is 165 tons. This firm supplied a bearing of Hoffmann design consisting of 14 cast-iron blocks without

# FORSHUVUDFORSEN HYDRO-ELECTRIC SCHEME, SWEDEN.

Fig. 112. Bus-Bar System on Third Floor of Power Station.

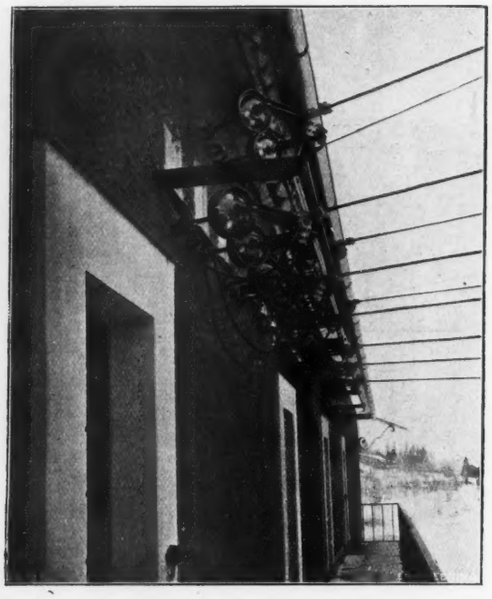


Fig. 113. Transmission Lines Leaving Power Station.

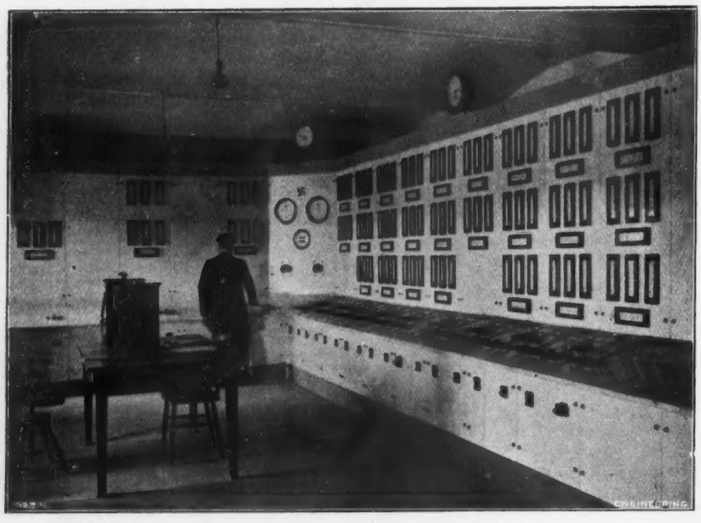


Fig. 114. Domnarvet Sub-Station.

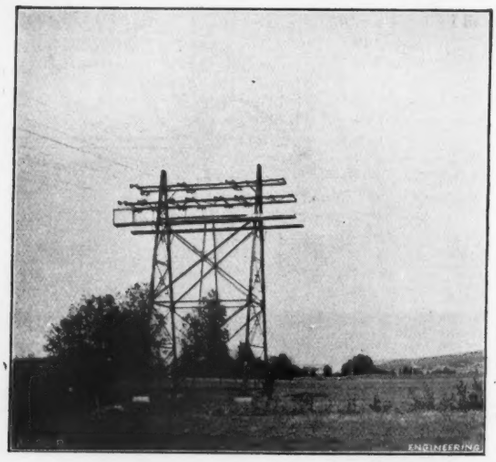


Fig. 115. Strain Tower on Transmission Line.

lining and revolving with the shaft. The load is transmitted to these sectors through a laminated circular spring. The chief difference between the two turbines is in the arrangement of the servo-motors. As stated above, this gear in the case of the No. 1 machine is in the pit just above the cover. In the No. 2 turbine the servo-motor is arranged on the generator room floor. The servo-motor operates direct a vertical shaft terminating just below the floor in a double arm lever. From this two connecting links transmit the movement to another vertical shaft in the pit, the guide vane control ring being operated from the lower end of this. The No. 2 governor is driven by belt with guide and tension pulleys embodied in the drive.

The pumps for the pressure oil have relief valves which open when the pressure reaches a maximum value of 15 atmospheres and close when this is reduced again to the minimum of 12 atmospheres. The independent electric drive adopted for the oil pumps which has been previously adopted at the Untra power station, allows free choice of position for the pumps in addition to having the advantage that they may be run independently of the actual turbines they are intended to serve, and in the case of emergency could be made to serve another machine. The inertia of the revolving parts controlled by the governors amount to about 11,000,000 ft.-lb. The efficiency of the two machines is indicated by the curves shown in Figs. 108 and 109.

In Figs. 110 and 111, which show the interior of the power station, the No. 2 generator is in the foreground, No. 1 being in the background. The servo-motor and governor of the No. 2 machine can be seen in Fig. 110 between the two generators. The two oil pumps are visible in Fig. 111 against the right-hand wall. One may also be seen in Fig. 107.

The generators are designed for 3-phase current at 10,500–11,000 volts, 50 cycles and a continuous load of 6,500 kv.-a. One of the generators is shown in outside elevation and section in Fig. 107; they are also well shown in the views Fig. 110 and 111. In each case the rotor has 72 poles and is made of cast steel. For transportation purpose it is divided in four segments held together by bolts in the rim, which are locked by keys and steel rings, shrunk on the hub. The poles are bolted to the rim and have laminated pole-shoes, attached by means of dovetails and bolts. For the purpose of obtaining a smooth field curve each pole shoe is divided into five equal sections, which are circumferentially displaced in such a way as to compensate for the distorting influence of the open slots in the stator core. The field winding consists of flat copper, wound on its thin edge on a former of insulating material fitted over the pole. The weight of the revolving field and the shaft amounts to 82·5 tons (182,000 lb.).

The shaft is carried by a lower and by an upper bearing. The bearings are housed in a lower supporting spider casting with four radial arms, and an upper spider with eight arms, both spiders being held by the stator frame.

The lubricating oil for the upper bearings is circulated by means of a spur wheel pump in the same way as the oil for the thrust bearing. The pump is placed on the lower spider and is driven from the generator shaft by means of gearing. The oil passing from the lower bearing runs into an annular oil receiver, from which it is pumped through an inspection glass on the highest point of the pipe, to the upper bearing. Under this bearing there is an annular collector, attached to the shaft, and from there the oil flows by gravity to the lower steady bearing. At a suitable height above the floor the

pressure pipe is provided with a manometer and a valve for regulation of the oil supply. Cooling of the oil is not necessary.

At the outer ends of the arms on the lower spider casting there are four air brakes, making contact with the under side of the rotor rim. Large screws are also provided for supporting the rotor and the runner when the thrust bearing has to be removed.

The stator is divided in four segments bolted together. It is carried by eight columns, on which the upper spider rests. The lower spider bracket rests on the base plates of the columns. The laminated core of the stator is held to the cast-iron frame by dovetails and is clamped between the end plates by means of bolts.

For ventilating purposes eighteen air ducts are provided in the stator. Their distribution was fixed after careful heating tests on a model in the laboratory. At several places in the core, as well as in the armature winding thermo-couples and resistance-spirals of thin copper wire are placed in order to make it possible to measure the temperature at these places.

The armature winding is placed in open slots, two to each pole and phase, and is made of solid square copper conductors, with the exception of the two layers next to the air-gap, which are made of stranded conductors in order to minimise the losses caused by eddy currents set up by the leakage flux across the open slots. The winding is held in the slots by wooden wedges. The armature coils are form-wound and insulated by tubes of moulded mica, the space between conductors being filled with insulating compound according to the Heafely method. In order to minimise as far as possible the electrical stresses on the insulating material at the point of entering the core a tinfoil lining is placed just inside the outer layer of the micanite tube, where it enters the slot, and electrically connected to the core. The ends of the armature coils are securely fastened to the frame of the stator by means of insulated metal clamps and heavy bolts in order to withstand the mechanical stresses when short-circuits occur.

In order to determine the efficiency and the more important characteristics of the generators and turbines, they were subjected to very thorough tests after their erection in the power house. The results of the generator tests are tabulated below :—

| — | $\cos\phi = 1$. | | $\cos\phi = 0{\cdot}75$. | |
|---|---|---|---|---|
| | 1/1 Load 6,500 Kw. | 3/4 Load 4,875 Kw. | 1/2 Load 3,650 Kw. | 1/3 Load 2,438 Kw. |
| Efficiency, excluding exciting and ventilating losses .. | 0·97 | 0·96 | 0·95 | 0·94 |
| Power required for exciting, kw. .. | 28 | 70 | 48 | 34 |
| Power required for ventilation, kw. .. | — | 50 | — | — |
| Increase of voltage when full load is switched off .. | 8% | 19% | — | — |

The short-circuit current at no load excitation is 166 per cent. of the full-load current.

The ventilating air is drawn through the generators by fans, one for each generator, run by vertical 3-phase 75-h.p. motors at a maximum speed of 720 r.p.m. The maximum quantity of air, required for one generator, amounts to about 15 cubic meters (530 cub. ft.) per second, and the rate of flow can be reduced by regulating the speed of the motors, for which purpose they are provided with variable resistances.

The exciter current is supplied by a motor-generator for each generator, the motors of which are directly connected to the generator terminals through transformers. When starting a generator, the exciting current is supplied by a battery of about 600 ampere-hours capacity. As soon as the alternating-current voltage begins to build up the exciter starts, and when the normal speed has been reached and the exciter direct-current voltage brought to the same value as the battery voltage, the exciter is connected to the field winding and the battery simultaneously disconnected.

The battery also supplies current for operating the oil circuit-breakers and to the more important auxiliaries such as the oil pumps for the governors, the cranes, the gate-hoisting machinery, &c., as well as to the lighting system.

For supplying direct-current during the regular running of the station a motor-generator of 80 kw. is provided. As a reserve for this motor-generator and for the exciters, another motor-generator of 80 kw. is installed. The exciter motor-generator can be started also by an auto-starter, by means of which the change over from the reserve-exciter to the normal exciter can be made without any interruption of the main circuit. The exciters, the motor-generators and the switch gear were supplied by the Allmänna Svenska Elektriska Aktiebolaget (ASEA), Västerås, Sweden, the generators and ventilators by the Elektriska Aktiebolaget A.E.G., Stockholm.

The generator room is served by an electrical overhead crane of 85 tons and 15 tons capacity.

The switch gear is installed in a four-storey building at the eastern end of the power house. Fig. 112 shows the bus-bar system on the third floor of this building, while Fig. 113 shows the transmission lines leaving the power house.

Power is transmitted at the generator voltage of 10,000 volts, a distance of 3½ miles to the Domnarvet Sub-station, the interior of which is illustrated in Fig. 114. The transmission line will ultimately consist of four 3-phase lines, each having a cross section of 3 by 120 sq. mm. (3 by 0·186 sq. in.), carried on steel towers spaced 160 meters (525 ft.) apart, and connected together by two 50 sq. mm. (0·078 sq. in.) earthed steel wires. Fig. 115 shows a typical strain tower at a point where the line changes direction.

By the spring of 1921 construction work had so far advanced as to allow of the impounded water being raised to its final elevation. The installation of the machinery was carried out at the end of 1921 and during the beginning of 1922. The first unit was put into operation in December, 1921, and the second unit in March, 1922.

One of the most important auxiliary works required during the construction was a temporary bridge over the river. A wooden frame-work bridge designed by Professor Forssell, with corrugated iron "Bufo" washers was used for this purpose. The bridge level was arranged considerably above the dam piers and the substructure of the power house, and it was provided with a double decauville track. The bridge was made in three spans of 24·75, 27·75 and 43·50 meters (81·20, 91·05 and 142·72 ft.), with abutments of wooden trestles. It was designed for a live load of 16 tons (35,000 lb.) on a length of 8 meters (26·2 ft.), and, in addition to that, 100 kg. per square meter (20·5 lb. per sq. ft.), corresponding to a live load of 450 kg. per square metre (92·2 lb. per sq. ft.) or 3-ton trucks. It has since been possible to sell this bridge, for erection at another place, so that the design proved very advantageous.

The work on the power plant was carried out under the management of the Stora Kopparbergs Bergslags Aktiebolag itself and under the supervision of Mr. Serrander.

The general design and layout of the plant, covering all structural details, except in the case of certain parts delivered by makers to approved specifications, was entrusted to the Vattenbyggnadsbyrån, consulting hydraulic engineers, of Stockholm. The electrical equipment was planned by the chief electrical engineer of the Bergslaget, Mr. A. G. Sundin, in collaboration with Messrs. Bergman and Co., of Stockholm.

Regarding experience with the plant, since it has been in operation it may be mentioned that the dam rollers, the two biggest of which were the largest in the world when designed, have worked entirely satisfactorily. With the aid of the heating arrangements it has been possible to regulate the discharge without any difficulties, even in the most severe winter weather, although this is a rather complicated matter on account of the necessary weekly storage of the flow. No manual labour has been required for this operation. It should also be mentioned that the revolving fish screens, which have been tried for the first time at Forshuvudforsen, has worked well and proved a great labour-saving device.

The arrangements for logging have also proved very convenient. The logs are conducted, without any difficulties, to the different sluices in the dam, passing through them without being damaged in any way. Actually, this work has been facilitated considerably by the erection of this dam, as the natural rapids at Forshuvudforsen caused a great deal of damage to the timber being floated down, and log-jams often formed.

As may be gathered from the results of the efficiency tests quoted, the machinery complies with very stringent requirements. It has worked excellently since it was first put in operation. In particular, the arrangement for generating the exciter current has proved extremely suitable for the purpose.

## THE DEMOLITION OF THE HARBOUR AND DEFENCE WORKS OF HELIGOLAND.*

By LEOPOLD HALLIDAY SAVILE, M.Inst.C.E.

THE author describes the arrangements made, and the methods adopted, consequent on the decisions in the Treaty of Peace between the Allied and Associated Powers and Germany, signed at Versailles on June 20, 1919. The general arrangements for carrying out these decisions were placed under the control of a Naval Inter-Allied Commission, which deputed the supervision of the works of demolition to an Admiralty Naval Sub-Commission, the engineering work being supervised by the Civil Engineer-in-Chief's Department.

The Sub-Commission arrived in Heligoland on February 25, 1920, and was withdrawn in September, 1921; the subsequent completion of the outstanding items of demolition work was carried out under the superintendence of the Main Inter-Allied Commission in Berlin, assisted by a representative of the Civil Engineer-in-Chief's Department at the Admiralty, who paid periodical visits of inspection until the completion of the programme which had been drawn up by the Sub-Commission before its withdrawal.

It is believed that the work involved is by far the largest work of deliberate demolition ever undertaken, comprising the rendering ineffective of harbour works and fortifications which had taken upwards of 24 years to construct, and had cost approximately 35,000,000*l.* sterling. The author gives first a short description and history of Heligoland. The island lies about 57 miles from the entrance to the Kiel Canal, and is about 1 mile long by ½ mile broad, rising on nearly all sides vertically out of the sea to an average elevation of 170 ft. above high water. The elevated plateau is known as the Oberland, while the small area at the foot of the cliff at the south-east corner of the island, where the only town exists, is known as the Unterland.

When Germany obtained possession in 1890, an extensive scheme was initiated for the construction of an outer harbour, to be used largely as a base for submarines, on the Unterland, and heavy fortification works, with underground barracks, hospitals, power stations, &c., all hewn out of the solid rock on the Oberland. The rocks comprising the island are of Triassic age, Bunter sandstone, Keuper, Lias, Oolite, Muschelkalk and chalk (now denuded), topped by Pliocene (the "brown tock"). Strata of the Neocomian series are exposed, not in the cliffs of the present island, but in certain banks visible at low water, and show the remarkable nonconformity with the cretaceous.

The demolition of the electric power-houses, of the inclined tunnel leading to the fortifications on the Oberland, and of the fortifications and underground works on the Oberland are not described in detail.

The original German estimate of the time required to carry out the demolition was seven years, but after the arrival of the Sub-Commission at Heligoland, and after further consideration, the estimate was reduced to three years, which was found to suffice, owing to the efficient manner in which the work was undertaken and carried out. A list of the items comprised in the fortifications and harbour works is given in the paper, and details of the original construction of the main items of the harbour works and the methods of demolition employed are stated in full.

Statistics give details of the cubic measurements of concrete and brickwork of each item demolished, linear feet of holes drilled, total weight of explosives used, quantities of explosives used per cubic yard of materials, and the cost in man-hours per cubic yard of concrete, &c., demolished. The total quantities of concrete and brickwork demolished in connection with the harbour works amounted to 195,435 cub. yards, and of timber cribwork with stone and sand filling, 53,416 cub. yards. The total weight of metal arising out of the demolition

* Abstract of paper to be read before the Institution of Civil Engineers, Tuesday, February 24, 1925.

of armament was: steel and wrought iron, 4,139 tons; cast iron, 3,416 tons; brass, 120 tons.

Three methods adopted for the destruction of metal were used: (*a*) Oxy-hydrogen flame; (*b*) oxy-acetylene flame; and (*c*) pure oxygen for burning cast-iron.

The explosive used for nearly the whole of the work was described by the Germans as "Shell Filling C. 88," and closely resembled "T.N.T." A description of the drills used, including particulars of types of bits, air consumption and pressure, &c., is given in the paper.

The whole of the demolition work was carried out with German labour and plant employed under direct German supervision. The methods adopted for carrying out the work were so efficient and satisfactory that it is not considered they could have been improved upon either for rapidity or economy. During the main progress of the work approximately 800 men were employed, and only five fatal accidents occurred from commencement to completion, in spite of the (in many instances) dangerous nature of the work. The fortifications on the Oberland have been so completely destroyed that the ground which has been filled in over the sites of the battery groups is again available for agricultural purposes, and the island has reverted to its use as a summer resort.

## THE MADRID WATER SUPPLY.

IN the middle of the sixteenth century Madrid had a population of 30,000 inhabitants and covered an area of 94 hectares (232 acres). The potable water supply at that time was obtained from wells which had been sunk at various parts of the township. From the above date the population increased, slowly at first, but much more rapidly from the commencement of the eighteenth century, and with the increase in population a more abundant water supply than was afforded by the wells was often badly needed. Nothing much was attempted in this respect until the accession of King Charles III, who reigned from 1759 to 1788, when several water supply schemes were elaborated. The first scheme on record is one dated 1786 for delivering to Madrid water from the rivers Lozoya and Jarama, adding, lower down, water from the river Guadalix, the highest intake then contemplated being in the vicinity of Pontón de la Oliva. After many years spent by eminent Spanish civil and military engineers in studying the problem and in devising measures for solving it, a decree for constructing a conduit, now styled "Canal de Isabel II," was finally signed in March, 1848. The water supply system as it now exists is illustrated in the annexed map, which also shows an extension planned for future execution. The map and particulars given in the present article are taken from the Madrid *Revista de Obras Públicas*.

The river Lozoya has its source in the Guadarrama Mountain range north of Madrid, and, as above stated, this river was the first one selected; the first intake was placed at Pontón de la Oliva. Actual work was only started four years after the signing of the decree, in the commencement of 1852, and was carried out in five sections distributed over the distance from the intake down to Madrid. Still further delays occurred, due to financial and other difficulties; these were finally overcome and water from the intake first reached the capital in June, 1858.

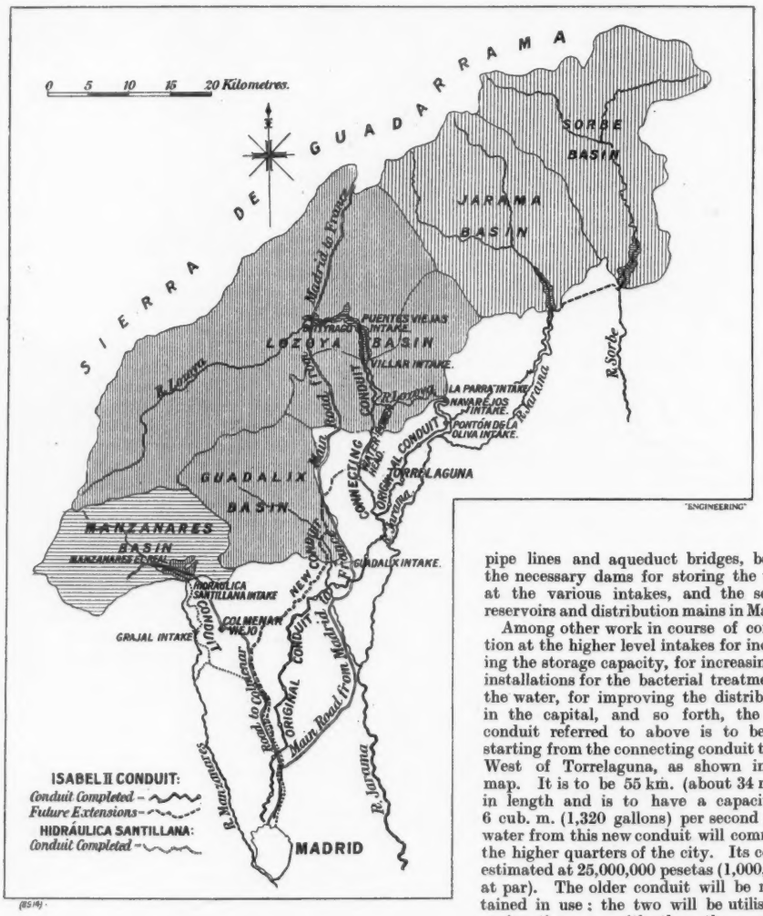
At a later date reservoirs and other intakes were built, notably at Puentes Viejas and at Villar higher up on the river Lozoya. The storage capacity at these two localities is 23 million and 22 million cubic metres (5,060 million and 4,840 milion gallons), respectively. Extensions are now being carried out at Puentes Viejas for increasing the storage capacity at that part of the system to 50 million cubic metres (11,000 million gallons). The two intakes here referred to are worked in combination. When the water in the river is quite clear, it flows from Puentes Viejas to Villar in a "clear water" conduit; when it is slightly turbid it is allowed to settle at Puentes Viejas before flowing to Villar; if it is very turbid it is not collected but is diverted at Puentes Viejas through a canal which delivers it into the river again at a point below Villar.

In the twelvemonth ending with September 30 of last year, Madrid, having a population of 814,000 inhabitants, consumed 66 million cubic metres (14,520 million gallons) of water supplied to it by the Isabel II water conduit—a daily average of 181,000 cubic metres (39,820,000 gallons). The water is of most excellent quality in every respect. The conduit, from the reservoir at Villar down to the service reservoirs in the Metropolis, has a length of 91 km. (56¼ miles), and is in two sections. A connecting conduit, 24 km. (14¾ miles) in length, takes the water from the Villar intake to a point on the original conduit south of Torrelaguna. This is a covered conduit having a capacity of 8 cubic metres (1,760 gallons) per second. It was built in 1911 to supplement the upper section of the conduit between the same point and the La Parra intake. The conduit from the junction near Torrelaguna to Madrid, 67 km. (41¾ miles) in length, is also covered; it has a capacity of 2·7 cubic metres (594 gallons) per second. This latter conduit is the original one, built in 1858 for a population of 230,000 inhabitants, the population of the city at that date. It has become insufficient for the present-day population, which has increased almost four-fold since 1858, and is still on the increase. During last summer the consumption reached 233,000 cubic metres (51,260,000 gallons) in one day. In view of this shortage, a scheme has been approved for the building of a new conduit from the connecting conduit down to Madrid, as shown in the map.

The terminal reservoirs in Madrid are three in number, having together a capacity of 630,000 cub. m. (over 138,000,000 gallons); their principal object is to ensure the supply during any temporary interruption in the flow of the conduit. As these reservoirs are not at a sufficiently high level for delivering water to several modern quarters of the capital, a pumping station has been built which delivers water to the top of a water-tower. The station is equipped with electrically-driven pumps capable of lifting 1·4 cub. m. (308 gallons) per second to a height of 35 m. (115 ft.). A steam-driven pumping plant is being added as a standby. The electric energy is derived from the water of the Lozoya river. The connecting canal, as above stated, enters the one first built at a point near Torrelaguna; at that point there is a fall of 150 m. (about 500 ft.) in a length of 1·5 km. (about 1 mile). This head has been turned to account for generating current at a power station located at Torrelaguna. The present plant is capable of developing 6,000 h.p.; it is being enlarged for the production of an additional 3,000 h.p. The current is supplied to Madrid at a pressure of 45,000 volts by a line 50 km. (about 31 miles) in length; a portion only of the electric energy is used for raising water at the water tower, the remainder being sold to power stations in the city. An occasional water supply is derived from the river Guadalix by a conduit 4 km. (about 2·5 miles) in length connecting that river to the original conduit and having a capacity of 3 cub. m. (660 gallons) per second.

The, now supplementary, La Parra intake from the river Lozoya was the normal feeder of the Isabel II water system until the connection to Villar by the connecting conduit built in 1911. The La Parrain take permits the collection of 1·2 million cub. m. (264 million gallons) of water available in the vicinity of Villar and below the level of the connecting conduit, besides other water in the lower Lozoya basin. This intake at La Parra is not provided with the very complete settling arrangements which obtain in the combined systems at Puentes Viejas and Villar, but it forms a most valuable adjunct when it is found convenient to cut out the connecting conduit for inspecting the installations at the higher levels.

The construction of the Isabel II conduit, intakes and reservoirs carried out from 1854 down till the end of June last, cost a total sum of 107,500,000 pesetas (about 4,000,000*l.* at par). The whole of the work was designed and carried out by the State, who contributed much the greater part of the necessary funds. The work consists of open channels, culverts, cast-iron pipe lines and aqueduct bridges, besides the necessary dams for storing the water at the various intakes, and the service reservoirs and distribution mains in Madrid.




Among other work in course of completion at the higher level intakes for increasing the storage capacity, for increasing the installations for the bacterial treatment of the water, for improving the distribution in the capital, and so forth, the new conduit referred to above is to be laid starting from the connecting conduit to the West of Torrelaguna, as shown in the map. It is to be 55 km. (about 34 miles) in length and is to have a capacity of 6 cub. m. (1,320 gallons) per second; the water from this new conduit will command the higher quarters of the city. Its cost is estimated at 25,000,000 pesetas (1,000,000*l.* at par). The older conduit will be maintained in use: the two will be utilised in conjunction one with the other, and it will be possible to cut out either temporarily for inspection purposes and repairs if and when necessary.

A further increase in the supply is being planned by a connection of the rivers Jarama and Sorbe with the existing conduit, as indicated in the map, which shows that storage reservoirs would be built in both basins, the reservoirs being connected together and to the existing conduit close to Pontón de la Oliva.

Certain quarters of Madrid are supplied with water by a private concern, the Hidráulica Santillana, which draws from storage on the river Manzanares shown in the map. We gather, however, that this supply is very limited compared with that afforded by the Isabel II waterworks.

S.S. "OBERON."—The Société des Chantier et Ateliers de Saint-Nazaire, of Penhoet, have recently launched, at Normandie à Grand-Quevilly, near Rouen, the steamer Oberon, which is being built to the order of the Finnish company Finska Angfartygs Aktiebolaget, of Helsingfors. The ship, which is intended for service as a mail-boat and merchant vessel between Finland and England, has a length of 88½ m., a moulded breadth of 13½ m., and measures 7·38 m. from the keel to the upper deck. The draught when the intended working load of 1,700 tons is carried is 5·64 m., and the speed 15 knots. When laden the vessel displaces 4,700 tons.

## THE 10-H.P. TRIUMPH MOTOR CAR.

THE Triumph Motor Company, Limited, of Coventry, have established an international reputation for their motor cycles, and it was therefore only natural that their entry into the car trade two years ago should have been received with great interest. In introducing their first model, having an engine giving a Treasury rating of 10 h.p., they aimed at producing a vehicle which would make a special appeal on account of its refinement, and their first production on these lines received a very favourable reception. This year they have introduced a second car on somewhat similar lines, but having an engine with a Treasury rating of 13 h.p.

We illustrate the 10-h.p. car below and on Plate XIV. The engine is a four-cylinder model, having a bore of 63·5 mm. and a stroke of 110 mm., giving a capacity of 1,393 c.c. It has a detachable head and side-by-side valves, a special feature of the latter being that they are masked with a view to minimising wire-drawing effects. The valves can be clearly seen in the end section of the engine, Fig. 5. From the same figure it will be seen that the combustion space is entirely free from pockets, and that the sparking plug is located approximately in the centre of the combustion space. The valve-operating mechanism is normal for this type of engine, the single camshaft being gear driven and located within the crankcase. The pistons, of copper-aluminium alloy, are of the Ricardo slipper type, with three rings at the top. The compression ratio is 4·5 to 1, and the crank-connecting-rod ratio is 4 to 1. The engine develops 24 h.p. at 3,000 r.p.m., and the characteristic is still rising slightly at this speed. The construction of the cylinder blocks is somewhat unusual, as will be seen from the sections Fig. 4 and 5. The crank-case is carried well up above the level of the base of the cylinder barrels, and this construction gives exceptional rigidity to the engine as a whole. The cylinder barrels are stiffened by an extension of the water jacket where they project below the blocks proper. The inlet and exhaust manifolds are cast in one piece, and are mounted on the near side of the engine, the exhaust manifold being below the inlet. A vertical type Zenith carburettor is fitted below the exhaust manifold, and the vertical branch of the induction pipe leading from the carburettor makes close contact with the exhaust manifold at the point where they cross, thus giving a hot spot arrangement. The exhaust gases leave at the front end of the manifold, and the exhaust pipe is carried well down below the frame where it passes under the engine.

The crankshaft is of the two bearing type, and is provided with a ball thrust race at the forward end. Lubrication is by splash throughout. The troughs are fed by an oil pump of the oscillating barrel and plunger type, details of which are shown in Fig. 6 and 7. From these figures it will be seen that the plunger is driven by a small crank, and as it oscillates it picks up oil from the supply branch, after which the opening is sealed by the rotation of the barrel and the oil is delivered by the downward action of the plunger to the delivery port. The magneto is mounted above the dynamo on the off-side of the engine, and is thus in a very accessible position. Both the dynamo and magneto are driven from the timing gear train. The starter is mounted on the near side, the starter ring being bolted to the front side of the fly wheel. The starter mechanism is totally enclosed in an extension of the engine bearer. An excellent feature of the design is the provision of a large oil filling orifice well up on the off-side of the engine.

The chassis generally follows conventional lines with the exception of the gear-box mounting, for which a special sub-frame is provided. As will be seen from the side elevation of the chassis, Fig. 2, both the engine and gear box are mounted at a slight angle, so that the transmission alignment is practically linear throughout when the chassis is loaded. The clutch is of the reversed cone type lined with Ferobestos, and the drive is carried to the gear box through a shaft having a universal joint at each end. The clutch-releasing mechanism operates on a collar on this shaft through the medium of a ball race. The gear box, shown in Figs. 8 to 10, is of especial interest, as by careful design the makers have been successful in producing a unit giving a particularly silent and easy change. The box is of substantial construction, and is bolted to the sub-frame by means of three lugs. The engagement of the direct drive is effected by dogs, the remaining gears engaging on the wheel teeth. The wheels on the lay shaft are made up in three groups locked together by dogs, and in this way a simple and compact construction is attained, while leaving the various gear groups of relatively short length. The main shaft is splined for the sliding gears in the usual way. The selector bars are arranged at the same height as the main and lay shafts, and are as close as possible to the former, giving an exceptionally short and rigid fork. The bars are locked in position by a spring-loaded pin with a hemispherical head. The box is of the four forward speed type, the ratios being 15·8, 10·3, 6·8, and 4·75 to 1, the reverse ratio being 20·4 to 1. A reverse catch is fitted on the gear lever, and an interlocking arrangement is provided which renders it impossible for two gears to be in engagement at the same time. A positive speedometer drive from the main shaft is arranged within the gear box, and the whole forms an interesting example of exceptionally compact and sound design.

*Fig. 11.*

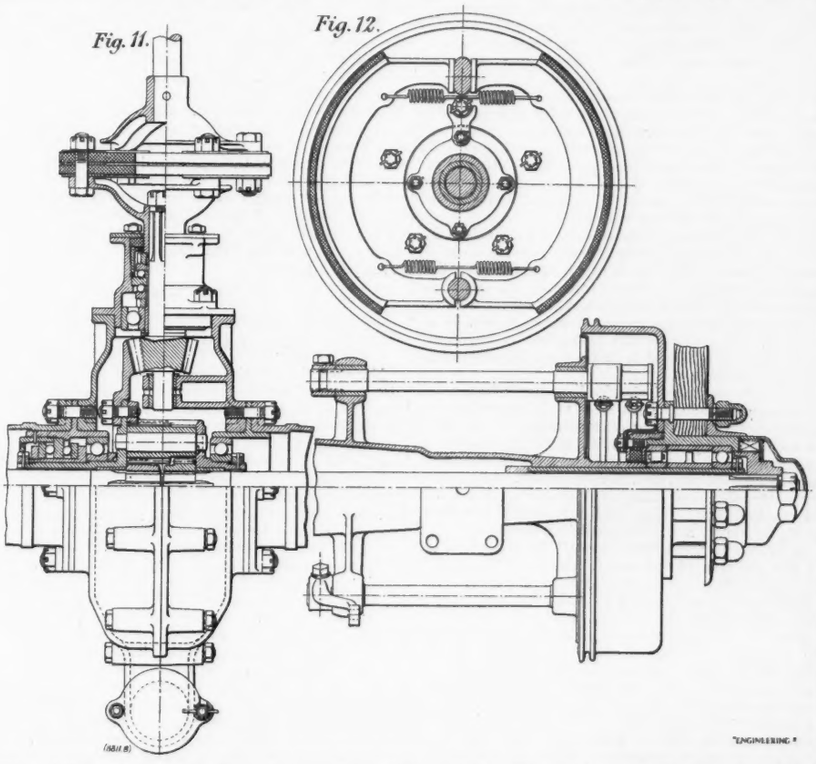


*Fig. 12.*



The cardan shaft carries double-disc universal joints at each end, the stars being hemispherical steel stampings giving exceptional lightness and strength. As Hotchkiss suspension is employed for the rear axle the cardan shaft is exposed. The rear axle, which is shown in Fig. 11, is built up with an aluminium-alloy casting for the centre piece carrying the crown wheel and differential, the bevel pinion being carried in a separate housing which is bolted to this centre-piece. The ball races carrying the differential assembly and the crown-wheel thrust race are mounted in separate housings which are bolted in with the rear-axle tubes, and the resulting arrangement is somewhat complicated. The final transmission is by spiral bevel, and the differential is of the spur-wheel type. The pinion shaft is mounted on a single ball race, additional support being given by a plain snout bearing. Thrust bearings are provided for both the crown wheel and bevel. The depth of engagement of the teeth of the two wheels can be regulated by a screwed collar which takes the thrust of the crown wheel.

The springing, both front and rear, is semi-elliptic. As will be seen from the plan of the chassis, Fig. 3, the batteries are split, one-half being carried on each side of the cardan shaft, and the weight throughout is similarly carefully balanced. Braking is normal, side-by-side internal-expanding brakes, as shown in Fig. 12, being fitted on the rear wheels, the brake drums having two ribs for assisting radiation. The brakes are operated by rods which are adjustable for length, and the compensator gear for both sets of brakes can be seen in the plan of the chassis. Steering is carried out by the usual worm and wheel, an unusual point in a car of this size being that the steering rake is adjustable. Provision is also made for taking up wear in the worm wheel and end play in the worm.

The petrol supply is on the Autovac system, and the lubrication throughout the chassis is by the Enot system. The electrical equipment is by Messrs. Lucas. The finish of the car at all points is exceptionally good, The wheelbase is 8 ft. 6 in., the track is 3 ft. 10 in. and the weight of the complete chassis is approximately 8½ cwt.

## SKILL IN RELATION TO PRODUCTION.*

By L. A. LEGROS, M.I.Mech.E.

IF we search the Oxford Dictionary for the definition and meaning of the word skill, we find under the head of "skill" and that of "skilful" meanings that only partially agree with those usually associated by the engineer with what he understands the word to mean. On looking further, under the word "skilled" one finds "possessed of skill or knowledge; properly trained or experienced," a meaning which is very close to that understood by the tradesman. Skill as understood by the engineer is a product of many factors. It involves the education of the senses in relation to work on materials; the education of the muscles to perform mechanical operations; the education of the brain in the requirements of the particular branch of industry; education in the relationship of that branch to allied industries; and it also requires education in the unrecorded lore of the workshop in matters of clearances, tightness of fit, lubrication, leakage, tightness for pressure or vacuum, knowledge of insulating materials for keeping heat in or out and also in the generation, distribution, and application of electricity; and, finally, such facility that the job entrusted to the tradesman is turned out to the requirements in a reasonable time.

The millwright of the earlier part of last century, who gradually became more rare towards its end, and who now has almost disappeared, was a man possessing a marvellous all-round knowledge of the machinery of the day, and of its construction by the primitive methods in use when he served his apprenticeship. The millwright could fit and turn, make a pattern, forge his own tools, insert cogs in a wheel and form their teeth to a very fair degree of accuracy, and he was an artist in the use of the hammer and chisel. To obtain such all-round skill of eye and hand required more than a five-year apprenticeship, because the simpler the tool, the file, for instance, the more difficult it is to use.

The turner of the succeeding decades was also an artist, a man who could turn a piston rod true on a lathe of which the bed was badly worn at the fixed-head end, who could cut screws, working out his own gears and grinding the tools to the proper shape and rake himself, and could do exceptional work when required for repairs. These men, to whom the machine was a help rather than a necessity, were those who built up the engineering trade of this country.

Into trade of this kind entered a factor destined to

* Presidential Address delivered to the British Section of the Société des Ingénieurs Civils de France, on Wednesday, February 18, 1925. Abridged.

have an enormous influence on the whole question of apprenticeship and skill: this factor was interchangeability. The necessity for interchangeability in machine details first made itself apparent about 160 years ago, when Fournier, the French typefounder, wrote in 1764 his "Manuel Typographique," the classic work on type, in which he refers to a "Réglement de la Librairie fait en 1723," which settled the height of type, but failed in the sizes of type because no one had been found capable of giving the requisite technical advice.* Fournier pointed out the necessity for working to multiples of a definite unit. To appreciate this at its full value, one must remember that of manufactured products, type-making machinery still requires the utmost exactitude, being only exceeded by such work as is to be found in gauges of the highest classes, in astronomical and surveying instruments, range-finders, and some branches of optical work. Even the gauge-maker finds that typecasting machinery presents difficulties, because, in addition to exactitude of size, disturbing factors are introduced by changes of temperature.

A far earlier example of interchangeability is the gauge or track of vehicles, which, as recorded by ruts in the streets of Pompeii, was fairly constant even at the time of the destruction of that city, a fact that shows an early appreciation of the interdependence of road and vehicle.

But the real call for interchangeability came with the development of light machinery and small arms. The sewing machine was required to be turned out in large quantities, and in its production the elimination of skilled labour from the manufacturing operations proper proved that where the cost of skilled labour was high, its special province lay in the making of trial machines, gauges, jigs, and tools only required in small quantities. In the case of small arms, it was necessary that parts should be made in quantity without requiring special fitting, and that any rifle should be capable of taking any cartridge of the same calibre. Similarly, on a larger scale, the rolling stock on railways was required to be so made that the coaches and locomotives of one line could run upon any other.

In the earlier stages of the engineering trade, manufacture as it is now understood, that is, something between making and mass production, did not exist. Machines were made practically individually without any idea that the parts of one could be used for another, or that a new machine could be made out of surviving parts of two that had become damaged. The costliness of work executed on individual parts involved great care in their use, and the individual replacement of any part that became worn or damaged was comparatively easy, for a man possessed of the skill of the one who made the machine could make parts to replace any of its details.

With the advent of lighter machinery, it was necessary to find methods for producing the parts in large quantities, irrespective of the machine of which they were to be components, and this led to the sub-division of labour operations in the machine shop. Sub-division of labour in the manufacture of small individual articles or parts was not new; it had been a recognised factor in the manufacture of such articles as the ordinary pin, parts of watches and clocks, and other small work. But the sub-division of labour in the machine shop resulted in the evolution of special machines adapted to one operation only, and so devised that there should be no waste of time in reading drawings or setting the machine. This stage involved the further step of rigorous inspection and of watching the machines and their product so that any departure from size was corrected before serious error had been made in large and important parts, or any large number of minor parts had been produced of incorrect dimensions.

The whole trend of this development was towards the elimination of skill in the individual operator engaged on production work, for skill, even when limited, involved thought and a break in the continuity of production.

The attempts to reduce the skill required for actual manufacturing processes have not, however, eliminated the necessity for skill in allied work, that is, in constructing the tools, jigs, and machines used for production. In the first place, it is necessary that one machine of a type should be produced individually, tested, and, if necessary, modified, before it can be adopted as the model on which to base manufacture in quantities. The parts that may be cheaply produced in quantity are, in most instances, expensive to produce singly, and when the model machine has been produced, tested, and passed, skill is required for making the gauges, the jigs, the dies, and the press tools for use in manufacture, as well as special gauges and other instruments for measuring the errors and ascertaining readily whether they are within the permissible limits. The making of gauges requires ability of a high order for working to small limits and obtaining true surfaces. Die-making has hitherto largely depended on the skill of the die-sinker, who has performed a great deal of the work by hand, though it is obvious that the machine operations adopted in making the individual parts of the single machine, the precursor of the type, are equally applicable to many of the operations of die-sinking.

It is in press-tool making, however, that we come to a class of work which requires not only the skill of the tool-maker, but a knowledge of the performance of similar dies and general experience in the behaviour of materials, and particularly of the flow of solids, in pressing operations.

Though increasing demand has resulted in the production of many machines in large quantity, there is still one branch of work that requires the skilled workman, and that is the repair of the machines when they have run a portion of their life. This question of repair is one of the big questions of the future, and the point of view taken varies in different countries according to the amount of skill available and its remuneration. Thus, in America, a locomotive is built for an estimated life of so many thousand miles; it is designed as nearly as possible to wear out equally all over in that distance, and then be thrown aside and replaced by another. In this country, the locomotive is replaced detail by detail, receiving new wheels and axles, a new boiler, and other parts, so that its active life is extended to four or five times that of the American locomotive. In the United States, the costliness of such skill as is required for repairs is almost prohibitive, and recognition of the fact that improvement is ever taking place involves consideration of the rate of change of the type of machine suitable for the work.

There are, however, many classes of machines for which it is necessary that the attendant or man in charge should either possess the skill himself for executing repairs, or should be able to command it. Of these skilled men, the marine engineer, always faced with the possible necessity of effecting repairs at sea, is an example. He must provide that inadequately recognised form of skill which is required for diagnosing trouble in machines.

The manufacture of standard parts to limits and in quantity having been the main factor in the development of the fully automatic machine, it may be wondered why the automatic machine is not more commonly used, but there are several reasons that, in combination, provide the explanation. The factors that determine how many automatics one man can set up and keep going efficiently are the class of work, its limits, and the quantities required.

It is in the word "efficiently" that lies the key to the problem of the use of the automatic. Sub-division of labour, as practised in Lancashire, will enable such an article as a stud, having two different sizes and lengths of screws with an intermediate collar, to be produced on plain lathes so cheaply by subdivision of the operations that six or seven men working with hand tools in successive operations on large quantities can produce at a lower total cost than the automatic with its long stoppages for change of product, its great first cost, its high maintenance charge, and its share of the wages of the automatic machine setter. In the case of the subdivided hand operations, each worker has skill of a limited kind, but it differs essentially from the all-round skill of the tradesman who has served an apprenticeship in several shops, and can perform all the operations with equal or greater accuracy, though not so quickly.

Consideration of these manufacturing problems has brought into view the importance of speed in the execution of work. It is not sufficient for a worker to produce the result in as long a time as he pleases to take over it, but it is necessary that he should be able to complete his job within a certain time. Now, the lower the skill required in the operator, the higher is the development of the machine capable of obtaining the desired result, the higher is its cost, and consequently the greater its time-rating. It, therefore, pays the employer better to employ the quick operator and to eliminate the slow. The treatment of this problem by both parties concerned has been very unsatisfactory in the past.

The trade unions have done equal harm by ignoring the difference that exists between different workers and allowing the work of time-workers to be slowed down to that of the slowest worker. The sequel to this has been a general slowing down that has spread from shop to shop till it has involved whole industries. This slowing down has, in some trades, assumed dimensions that have raised the cost of the product to an extent beside which the efforts of trusts and profiteers sink into insignificance in their share of the total cost incident on customer or consumer. This does not apply to every trade union, but it does apply to most of those which are concerned in metal manufactures and also in the construction of buildings.

In order to appreciate the meaning of this slowing down, "ca' canny," or whatever name may be given to it, one must first grasp the workers' idea of work and wages. It is essentially a doctrine of the immediate present, and can be best explained by an example. There are, say, 100 pieces to be made in a particular shop, and they are known to have taken two hours each when done at some previous time. A man new to the shop and put on to do these, may have done a very similar job elsewhere, and he may start to do them in one hour each. It will then be explained to him that he is doing someone out of a job; they will only last him about a fortnight, and when they are done, either he will be put off or someone else will be put off. By confining the argument to the actual moment, such questions as those of future orders, competition, and particularly foreign competition, are eliminated. The ultimate result must be either that the trade will be captured by the foreigner of different mentality, or the inventor and the engineer will find some other way of getting what they want to produce without employing so-called skilled labour, for it is an essential of skill that it attains the result in a reasonable time.

It needs knowledge of this peculiar mentality of the factory worker in order to discuss the problem with him, and any apparent success will probably prove shortlived, because it is only too easy for him to find examples in any works of men being discharged as soon as jobs are finished. It must be remembered that the margin available for saving out of the journeyman's wages is not large, and if he has a wife and family to consider, the uncertainty of tenure of his job and the prospect of an unhappy time at home while out of work is a very disagreeable outlook. Want of first-hand knowledge of labour conditions on the part of many who dealt with trade disputes during the war has been the cause of considerable subsequent unrest.

*(To be continued.)*

## LABOUR NOTES.

Most of the district organisations of the Miners' Federation of Great Britain have now indicated the lines upon which they think the wages of the workers in the industry should be regulated, and a report on the various proposals is to be submitted by the central body to a delegate conference at Blackpool on Thursday. The South Wales suggestions include a minimum percentage of 43½ per cent. over 1914, a 9*s.* per shift subsistence rate, joint representation by owners and miners for the re-enactment of Part II of the Mining and Industry Act, 1920, reforms in the auditing of colliery accounts, discontinuance of the carrying forward of deficiencies on profits account, and the making of union membership a condition of employment. Durham's proposals include a minimum of 12*s.* per day for all adult workers, no deficiencies on profits account to be carried forward, and division of the proceeds of the industry in the ratio of 88 to wages and 12 to profits. Lancashire desires a national joint board of employers and workmen "to establish and control the conditions which are of general application throughout the country," wages to be on 1914 base, *plus* a percentage equal to the increase in the cost of living, and joint control in each area of selling prices and costs of production. Other Lancashire proposals are that, in the determination of profits, regard be had to the aggregate capital invested, the employer to be entitled to a fair return thereon; the division of surplus profits between workmen and employers in an agreed ratio; membership of the union to be a condition of employment; and two weeks' holiday a year with pay.

In view of the stipulation that building trade wages and conditions, as laid down in the Standing Orders of Glasgow Corporation, must be observed, Messrs. G. and J. Weir, Limited, Cathcart, have declined to accept the contract, which had been offered to them, for 20 steel houses. In a letter to the Housing Committee, the firm say:—"We much regret that this situation has arisen, but the acceptance of the contract with its implications that we must regulate the method and rates of payment and other matters of internal economy in our factory according to the standards set up by an authority whose methods we do not use, and whose members we do not employ, would detrimentally affect our efficiency, rapidity, and cost of production, and would not be helpful towards the solution of the housing problem which we have in view. We therefore regret we are unable to confirm our acceptance of the terms stated in your letter."

The Co-partnership Bill, which has been presented in the House of Commons by Mr. R. Shaw, seeks to provide for the formation of a body to be called the

* Moxon, the English authority on type, who published his Mechanical Exercises in 1680, confined himself to giving the number of lines to the foot of the different body sizes of type.

Industrial Co-partnership Commissioners, to consist of five members—one appointed by the Trades Union Council, one by the Federations of Employers in British Industries, one by the Labour Co-partnership Association, one by the President of the Board of Trade, and one, who shall be chairman, by the Chancellor of the Exchequer. After the passing of the Act any company carried on for profit and incorporated by Act of Parliament or Royal Charter, or registered under the Companies Acts, 1908 to 1917, may make provision by a scheme to be submitted to the Commissioners for the division of its profits between the capital and labour employed. Every such scheme shall provide for the payment to all employees, in addition to any share in the profits, of wages not less than the rates commonly paid in the district; for fixing a basic rate of interest upon capital invested in the business, such basic rate to bear relation to the risks involved in the business; for the investment of some part, not being less than one-half, of the employee's bonus in the capital of the company; and that the employee's bonus shall not be liable to forfeiture for any legal act or omission of the employee. Companies entering into the scheme are to pay income-tax at three-quarters of the rate ordinarily charged and stamp duties for the issue of capital at half the rate in force.

According to the "Monthly Report" of the United Society of Boilermakers and Iron and Steel Shipbuilders, the trades employing members were a little busier in January than they were in the last month of the old year. The number of "members signing the books" at the end of January was 21,213 as compared with 22,063 at the end of December, and the branch expenditure for the month was 103,840*l.* 18*s.* 4*d.*, as compared with 109,910*l.* 5*s.* 8*d.*

The report of the General Federation of Trade Unions for the final quarter of 1924 gives the number of affiliated societies as 118 with a gross membership of 834,161, 458,569 of whom are on the higher scale and 375,592 on the lower scale. Contributions received amounted to 13,480*l.* 13*s.* 3*d.*, and benefits paid to 1,269*l.* During the three months the funds increased from 126,562*l.* 10*s.* 4*d.* to 139,228*l.* 16*s.* 10*d.* In his report, Mr. W. A. Appleton, the general secretary, says that in addition to submitting a précis to, and giving evidence before, the Committee of Inquiry into Industry and Trade, the Management Committee has carried much further the instructions of the annual general council meeting in respect of resolutions which that body adopted in July last. The Management Committee, having frequently pressed, during the deplorably long period of trade depression, for the appointment of a committee of inquiry into causes and possible remedies, gladly responded to the request for its views and awaits with great interest the findings of the official body.

In January there was a further decrease in the membership of the Amalgamated Engineering Union, the total falling from 240,872 to 237,862. A decline of 1,278 was recorded in the number of unemployed members, but 15,914, or 7·28 per cent., after certain adjustments, are still idle. Branches of the union are reminded by Mr. Smethurst, the general secretary, that the National Committee meeting in 1926 will consider suggestions for the alteration of rules. Attention is directed to Rule 14, clauses 11 to 15. Suggestion books are now in the branches, it is pointed out, and are to be returned to the General Office on or before September 1 next.

When the executive council of the Amalgamated Engineering Union, in effect, instructed branch secretaries that the funds of the organisation were not to be used for the payment of the expenses of delegates to the Battersea conference of the National Minority movement, it was stated in the official organ of the Communist Party that by doing so Mr. Brownlie and his colleagues broke the rules themselves. In an editorial note in the February "Journal," it is stated that the charge is untrue. The decision of the executive is, says the writer—who is, presumably, Mr. Smethurst, the general secretary—in accord with the principle underlying the rule, and has been confirmed in a similar case by the highest court in the union, viz., the Final Appeal Court, which is composed of members who are working at the trade and elected annually by the members. The decision can, therefore, it is claimed, very properly be described as one that has been endorsed by direct representatives of the rank and file, uninfluenced in any way by the permanent officials of the union.

The number of unemployed members of the United Patternmakers' Association was 40 less in January than in December. The total is still high, however, being 742, and much hope cannot be built, Mr. Allan Findlay, the general secretary, suggests, on so slight an improvement, especially in view of the fact that the unemployed figures for the earlier month were probably swollen by the usual holiday increase. According to Mr. Findlay, the membership of the U.P.A. was 12,856 in 1921; to-day it is 11,701. "In three and a-half years," he goes on to say, "we are down 1,155, and while we know that many of these have left the trade and others left the country, the fact remains that too many are working at the bench whose weight and influence are not behind us at the moment, and the employers know it. Probably, a fair estimate of the number would be 20 per cent., including apprentices." It is the duty of the men in the shops, Mr. Findlay points out, to see that this cause of weakness to the movement for an advance of wages is removed.

A review of Russian Labour in 1923-24 given in the *Soviet Union Review* states that the average wage in all industries in September, 1924, was over 80 per cent. of the pre-war wage, and that, with the exception of those of the textile workers and miners, the wages of practically all classes of workers were very nearly equal to or above the pre-war level. In estimating the material condition of the workers of the U.S.S.R., as compared with their pre-war condition, it must be borne in mind, the writer says, that the worker in the Soviet Union to-day enjoys a variety of privileges, such as reduced charges for all municipal services (light, water supply, trams, &c.), reduced rents, cheap theatre and concert tickets, priority in free school accommodation for his children, cheap holidays at the rest homes and health resorts, and so on, which add considerably to the real value of his wages, as shown in bare statistical figures. It should further be noted, the writer says, that the ordinary working day for manual workers is now eight hours, and in dangerous and injurious trades six hours.

The total number of unemployed workers increased from 1,060,000 on October 1, 1923, to 1,261,000 on August 1, 1924. Thus, side by side, he says, with an expansion of industry and an increase in the number of workers employed, unemployment continued to grow. That result was due, however, very largely to the influx of workers from the villages into the towns, for, although Soviet industry can absorb a certain number of these new workers, its rate of expansion is not yet sufficient to provide work for all applicants. Between October 1, 1923, and October 1, 1924, the number of trade unionists in Russia increased from 5,550,900 to 6,430,500. In spite of the fact that membership of the trade unions is now entirely voluntary and subscriptions are collected from individuals and not, as formerly, automatically deducted from wages, about 95 per cent. of all the manual and non-manual workers in the U.S.S.R. are members of their respective unions.

At a meeting in London on February 16 the general managers of the railway companies formally acquainted the representatives of the Associated Society of Locomotive Engineers and Firemen with the demand for a general reduction of wages by 4*s.* per week in rural areas and 6*s.* per week in London and industrial areas. In an interview after the meeting Mr. Bromley said that the representatives of the Associated Society had not put forward any claim for increases of wages. They had simply told the companies that they could not entertain their demands. "We have heard the companies' case for reduction," he said, "and we are unable to agree. We have indicated to the companies our opposition to their demands, and so, for the moment, the matter rests. Nothing has been said so far about referring the question to the Wages Board. Speaking personally, I feel this is not our dispute, neither as an organisation nor as locomotive men. It was only quite recently that the companies made a claim against the locomotive men. It was argued out and fought out, and argued out again, and now, because of the troubles of other people, which have caused the companies to make a counter-claim for reductions, they are trying once more to involve our men. We cannot agree that this is our dispute, and we think we ought not to be concerned in it."

The Ministry of Labour reports that the number of unemployed persons on the registers of Employment Exchanges in Great Britain on February 9, 1925, was 1,243,000, viz.: 941,100 men, 35,900 boys, 231,500 women, and 34,500 girls. On February 2, 1925, the number was 1,238,287, 935,657 being men, 37,073 boys, 230,960 women, and 34,597 girls; and on February 11, 1924, it was 1,198,673. Of these 873,395 were men, 38,266 boys, 238,476 women, and 38,536 girls.

It is stated in the *Ministry of Labour Gazette* that among the 11,500,000 workpeople insured against unemployment under the Unemployment Insurance Acts in Great Britain and Northern Ireland the percentage unemployed at January 26, 1925, was 11·5, compared with 10·9 at December 22, 1924. Among the members of those trade unions from which returns were received the percentage unemployed was 9·0 at the end of January, 1925, compared with 9·2 at the end of December, 1924. The total number of persons registered at unemployment exchanges in Great Britain and Northern Ireland as unemployed at January 26, 1925, was approximately 1,287,000, of whom 969,000 were men and 243,000 were women, the remainder being boys and girls. At December 29, 1924, it was 1,319,000, of whom 1,003,000 were men and 250,000 were women; and at December 22, 1924, it was 1,213,000, of whom men numbered 930,000 and women 226,000. Employment was good on the whole in the jute industry, in some branches of the cotton trade, with millsawyers, with brick-makers, and with most of the skilled operatives in the building trades. It was fairly good in the silk and carpet trades and in certain sections of the metal trades. In coal mining, in the wool-textile industry, and in the section of the cotton industry spinning American cotton it was slack. In the iron and steel industry, in tinplate manufacture, and in the marine engineering and shipbuilding trades it continued bad.

There was a further slight increase in rates of wages in January. In the industries for which statistics are available the changes in rates of wages reported to the Ministry of Labour resulted in an aggregate increase of £62,000 in the weekly full-time wages of nearly 1,000,000 workpeople, and in an aggregate reduction of £7,400 in the weekly wages of 86,000 workpeople. The principal groups of workpeople whose rates of wages were increased, were coal miners in Yorkshire and the East Midlands, whose wages were increased by the equivalent of rather more than ½ per cent.; a considerable number of railway traffic workers, who received increases mostly of 2*s.* per week under a cost-of-living sliding scale; and gas workers, who obtained increases of ½*d.* per hour or 4*d.* per shift. Other important bodies of workpeople who were granted increases in wages included textile dyers, bleachers, finishers, &c., in Yorkshire, Lancashire, and Scotland; wool textile operatives in the West of England; building trade operatives in various towns in the East and South of England; house painters in Scotland; men employed by public works contractors in London; seed crushers and oil millers; men employed in the electricity-supply industry in various districts; and night-shift men employed by tramways undertakings. Under the Trade Boards Acts there were increases in the minimum rates payable in the perambulator and invalid carriage, paper bag and paper box, and brush and broom trades. The principal reduction in wages affected hosiery workers in the Midlands, whose bonus on earnings was reduced from 9*d.* to 8*d.* on each shilling earned. There were also reductions in the wages of ironstone miners in Cleveland and in those of blast-furnace workers in various districts.

The number of trade disputes involving stoppages of work reported to the Ministry of Labour as beginning in January was 35. In addition, 23 disputes which began before January were still in progress at the beginning of the month. The number of workpeople involved in all disputes in January, including workpeople thrown out of work at the establishments where the disputes occurred but not themselves parties to the disputes, was about 12,400. The estimated aggregate duration of all disputes during January was about 67,000 working days. These figures compare with totals of approximately 16,000 workpeople involved and 92,000 days lost, in the previous month. The number of days lost through disputes during January was smaller than in any month since February, 1917.

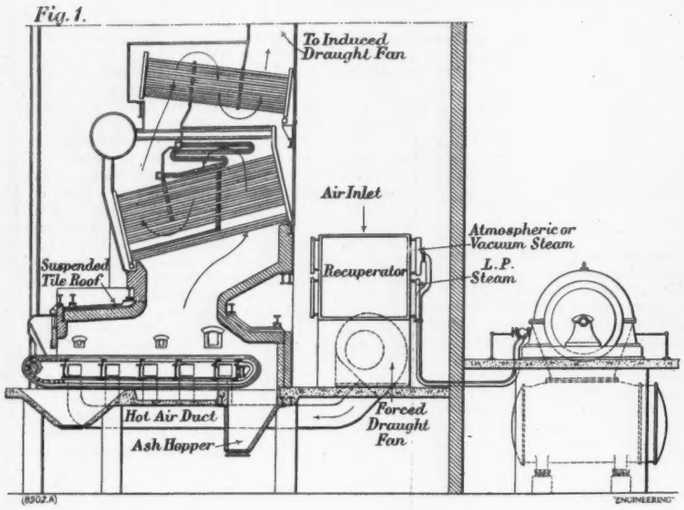
PRACTICAL NOTES ON THE THEORY OF THE MICHELL BEARING: ERRATA—In the article appearing in our issue of the 13th inst., on page 183, the fourth line from bottom of the third column, instead of "This is here the total pressure also," should read "The total pressure is $P_{total} = \pi\, 0{\cdot}0146 \frac{\lambda U}{\theta^2} = 0{\cdot}04587 \frac{\lambda U}{\theta^2}$; while on page 184, in the first column (15) the bracketed numerator should read $U_E$ instead of U.

TENDERS.—The Department of Overseas Trade, of 35, Old Queen-street, London, S.W.1, announce that tenders are invited by the Egyptian Ministry of the Interior for the supply and erection of a mechanical filter, complete with accessories and necessary foundations, and also the supply of material for use in two existing filters. Tenders will be received in Egypt until March 16. It is further stated that a growing demand exists in Japan for light motor fire engines, and in the Dominican Republic for reinforcing rods for concrete construction and galvanised sheets. Further particulars may be had on application to the Department.

# RECUPERATOR FOR BALANCED-DRAUGHT FURNACES.

CONSTRUCTED BY THE RILEY STOKER COMPANY, LIMITED, ENGINEERS, LONDON.

*Fig. 1.*



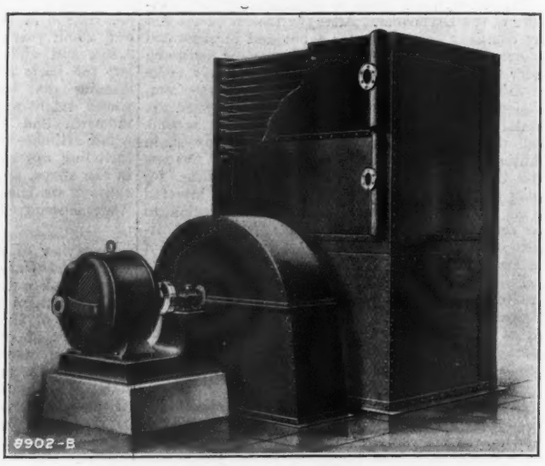




Fig 2

## RECUPERATOR FOR BALANCED-DRAUGHT FURNACES.

The recuperation of latent heat from partly expanded steam drawn from turbines in order to heat boiler feed-water is now generally practised in modern steam-power plants, a considerable saving in fuel being effected in multiple-stage steam heating by recuperating latent heat that would otherwise be dissipated in the condensing water. The Riley Recuperator, constructed by the Riley Stoker Company, Limited, Palace Chambers, Bridge-street, London, S.W. 1, applies the same method to heat to about 200 deg. F. the air used for combustion in balanced-draught furnaces, experience having shown that modern stokers and furnaces are quite suited for such moderately preheated air, and that the low-grade moist fuels generally used in power plants are more quickly ignited and burn with increased efficiency when supplied with air preheated to the temperature mentioned. In addition, there is a fuel saving due to the recuperation of latent heat from the partly expanded steam.

The arrangement of the appliance is shown in Figs. 1 and 2 above. Fig. 1 shows a typical application of the duplex down-flow type to a modern large boiler unit, while Fig. 2 shows the down-flow type of recuperator complete with a forced-draught fan of the single-inlet type. In cases where it is more convenient to use a Riley recuperator in the boiler-house basement, it is arranged for horizontal air flow, to suit limited conditions of head-room; and either type can be installed when desired in the turbine-house, with suitable suction ducts to the forced-draught fans in the boiler-house basement. The construction is standardised in nine sizes, to suit boiler units up to, say, 7,500-kw. capacity, or capable of generating about 90,000 lb. steam hourly each.

In all sizes and patterns welded joints alone are used, the batteries of air-heating radiators being assembled in sectional grids composed of pipes of circular section, giving straight flow of the steam from the inlet to the drain outlet. The water of condensation is discharged to the hot-well by steam traps, or, when steam is used at less than atmospheric pressure, by a suitable vacuum pump and receiver. The total heat of steam admitted to the appliance is utilised. The recuperator does not involve any increased power for the induced-draught fan. Its only effect on working cost is that the forced-draught fan supplied with the recuperator for handling the combustion air at 200 deg. requires slightly more power than a fan handling cold air.

While it is possible to utilise comparatively high-pressure steam with considerable superheat for a third-stage heating effect, both of feed water and of combustion air, the makers' experience indicates that 200 deg. F. is the preferable limit in both cases. An economiser receiving steam-heated water at 200 deg. will utilise practically all the available heat in the waste gases from the boiler in heating the feed water to about 300 deg. F; while if a flue-gas air preheater is substituted for the economiser, no corresponding fuel saving can be made by using high-pressure superheated steam to heat the feed water from 200 deg. to 300 deg., and the upkeep of stokers and furnace refractories will be unduly increased, it is stated, if the above-mentioned limit for the temperature of the air for combustion is exceeded. The Riley recuperator uses steam at atmospheric or less than atmospheric pressures, and with little or no superheat for the initial stage of heating the combustion air to, say, 120 deg., and the heat recuperated in this stage is about twice as much as that obtained in the second stage, in which the air is heated from 120 deg. to, say, 200 deg. by means of low-pressure steam with moderate superheat. Under normal load conditions the cost of the appliance compares very favourably with that of flue-gas air preheaters.

## THE SHARPLES CENTRIFUGAL SEPARATING MACHINE.

In our issue of March 7 of last year, on page 312, we made a brief reference to a comparatively new form of centrifugal separating machine for liquids, which had been successfully employed, among numerous other industrial applications, for the reduction of the ash content of fuel oils normally used for boiler firing so as to render them suitable for use in Diesel engines. We now propose to describe the design and construction of this machine, which we illustrate on pages 227 and 230, of this issue, and to deal briefly with some of its applications.

The machine, which is known as the Sharples super-centrifuge, and has been developed in the United States by the Sharples Specialty Company, of Philadelphia, is now being manufactured and marketed in this country by Super-Centrifugal Engineers, Limited, Imperial House, Kingsway, W.C. 2. The detail design of the machine differs according to the duty it is required to perform, but a typical example is illustrated in section in Fig. 1. From this it will be seen that a long tubular bowl is employed, the liquid being fed continuously into the bottom of the bowl and the separated constituents being collected in suitable receiving covers at the upper end of the bowl and delivered through spouts. The use of the tubular bowl is the most important feature in the design of the machine and is that upon which its efficiency depends. It will be remembered that, for a given peripheral velocity, the centrifugal force exerted on a rotating body is inversely proportional to the radius of rotation, while the tensile stress in the walls of the rotating container is proportional to the square of the peripheral velocity and is independent of the radius. The peripheral velocity is, of course, limited by the stress which the material of the container can safely withstand, but the centrifugal force for a given tensile stress can be increased by reducing the radius of rotation and increasing the speed of rotation at the same time so as to keep the peripheral velocity constant. In the Sharples machine the bowl is 30 in. in length and 4¼ in. in diameter externally, while its speed of rotation is 17,000 r.p.m.; with these dimensions, and at this speed, the centrifugal force exerted on a body on the periphery of the bowl would be 16,950 times the force of gravity.

The bowl, which is of steel, weighs about 35 lb., and is suspended by a flexible spindle from a ball bearing, as shown in Fig. 1. Details of the bearing and spindle and of the connection of the latter to the bowl are illustrated on a larger scale in Fig. 2. The bowl, as shown in Fig. 1, is enclosed in a conical cast-iron chamber formed in one with the main standard of the machine. A bracket bolted to the standard supports a small electric motor of about 2½ h.p., running at 3,450 r.p.m., and driving the spindle through a special form of woven-cotton belt; the latter is kept taut by a weighted jockey pulley running on ball bearings. It is, of course, quite possible to drive the machine from line shafting, the motor then being replaced by a speed-increasing gear. The latter has a pair of fast and loose pulleys on one side, driven from the line shaft by an ordinary leather belt and driving a second shaft through an internal helical gear and pinion at 3,450 r.p.m. The second shaft drives the bowl spindle pulley by means of a cotton belt, in a similar manner to that illustrated in Fig. 1 in connection with the electric-motor drive. In some cases, a small impulse steam turbine is used to drive the bowl directly, this arrangement being illustrated in Fig. 4.

No actual bearing is employed at the bottom of the bowl, but a guide bushing with a certain amount of clearance is provided to limit the lateral motion. When the liquid being treated has some lubricating properties, the arrangements illustrated in Fig. 3 are employed at the bottom of the bowl, but when treating non-lubricating fluids, such as varnish, as well as liquids containing gritty particles, it is necessary to exclude them from the guide bushing and to supply the latter with lubricant; this arrangement is illustrated in Fig. 5.

One of the simplest operations to which the Sharples centrifuge can be applied is the clarification of liquids containing a small proportion of solid, or semi-solid, matter in suspension. In such cases the upper end of the bowl and the collecting cover are arranged as shown in Fig. 6. The clarified liquid escapes through a simple outlet in the top of the bowl, is collected in the sheet-metal cover and delivered through a spout, while the solid matter is retained in the bowl from which it is removed at intervals. In certain cases when the solids have a lower density than some "carrier" liquid, such as brine, it is possible to arrange the machine to separate solids from liquids and to discharge them both continuously; as an example of this we may mention the separation of paraffin wax from petroleum. The form of cover used for this particular application is illustrated in Fig. 7. The carrier liquid, which can be fed in at the bottom of the bowl with the fluid to be treated, collects around the walls of the bowl and allows the lighter solid to float on it at a smaller radius, as indicated in the figure. The solid escapes between the outer edge of a gun-metal ring and the wall of the bowl, finally leaving through the lower of two outlets at the top of the bowl, as will be clear from the illustration. The still lighter fluid, which originally contained the solid matter, escapes over the inner edge of the gun-metal ring and leaves by the upper outlet as shown. Instead of adding the carrier liquid to the fluid to be treated, it can be supplied, under a suitable head, through a ring at the top of the bowl, as indicated in Fig. 7. It is then only necessary to supply sufficient

# SHARPLES CENTRIFUGAL SEPARATING MACHINES FOR LIQUIDS.

CONSTRUCTED BY SUPER-CENTRIFUGAL ENGINEERS, LIMITED, LONDON.

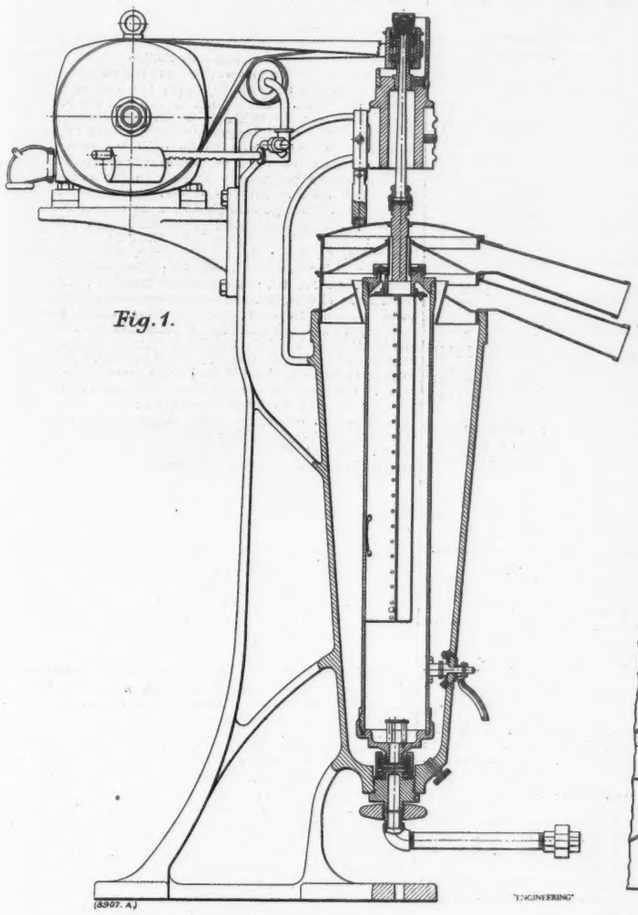



*Fig. 1.*

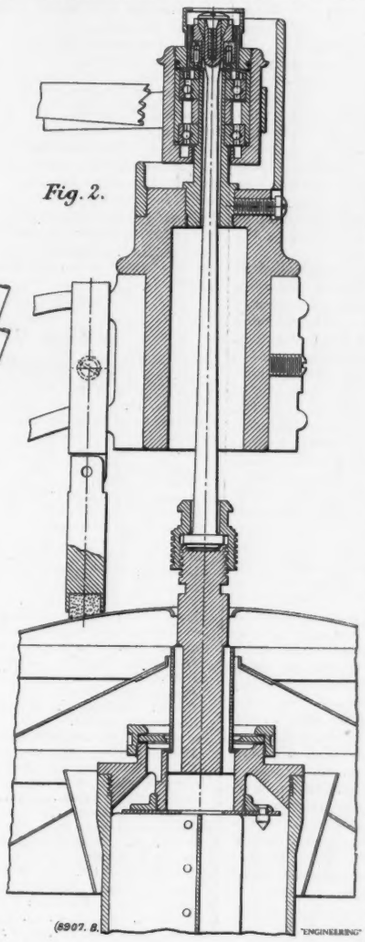



*Fig. 2.*

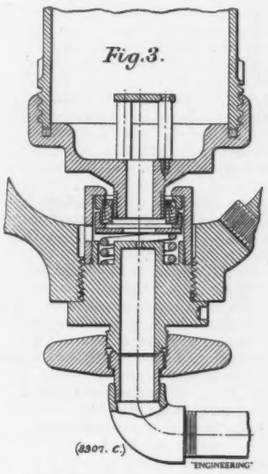



*Fig. 3.*

*Fig. 4.* STEAM HEAD.

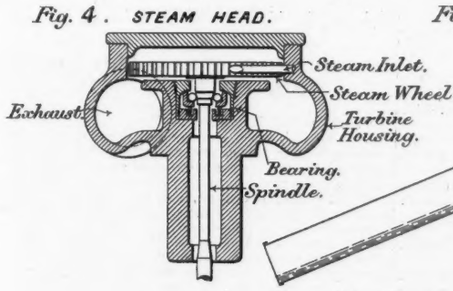



*Fig. 6.* CLARIFICATION OF LIQUIDS.

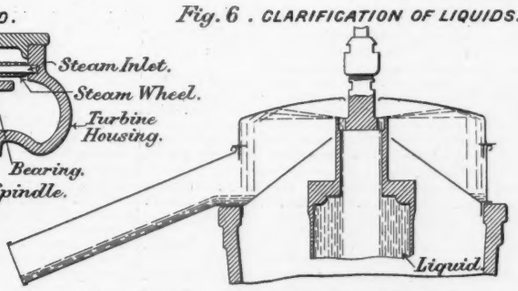
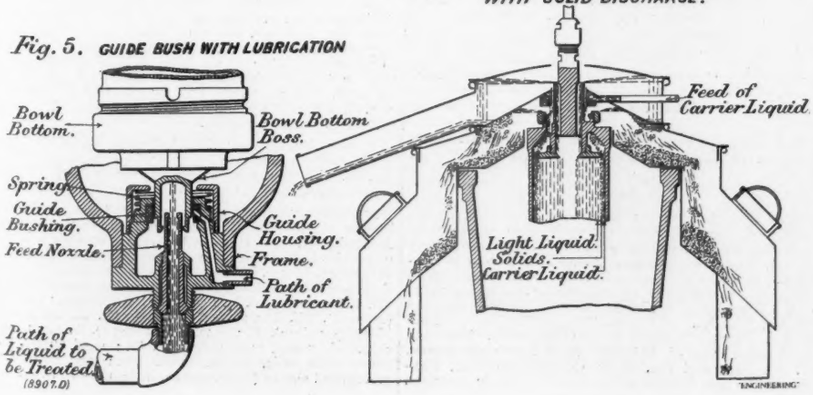



*Fig. 7.* CLARIFICATION OF LIQUIDS WITH SOLID DISCHARGE.

*Fig. 5.* GUIDE BUSH WITH LUBRICATION




of the carrier liquid to replace the comparatively small quantity which escapes with the solid matter.

One of the commonest applications of the machine is the separation of two liquids of different specific gravities, such as oil and water, it having been found possible to deal with the most intractable emulsions in this way. For this purpose the machine is arranged as shown in Fig. 1. A three-winged baffle is inserted in the bowl, as indicated in the illustration, its function being, of course, to ensure that the liquid passing through the machine is rotated at the same speed as the bowl. The friction which would otherwise occur between the fluid and the wall of the bowl is thus avoided, and the fluid is also subjected to the full centrifugal action. The baffle is held in position by arched springs which press firmly against the walls of the bowl when the latter is rotating, but relax when it is at rest so that the baffle can readily be removed for cleaning. The heavier liquid escapes from the lower outlet, passing over the inner edge of an external dam ring most clearly shown in Fig. 2. The diameter of the opening through this ring controls the position of the dividing line between the two liquids in the bowl and provides a means for adjusting the radial depth of the two liquids, so as to ensure their complete separation. The lighter liquid escapes through the upper outlet, and is collected by the cover shown, being delivered from one of the spouts, as will be clear from the illustration. The covers are kept in position by a hinged vertical rod having a fibre pad on its lower end as shown in Figs. 1 and 2. Attention may here be called to the brake shown near the bottom right-hand corner of Fig. 1, this brake being used to bring the bowl to rest rapidly at the end of a run. The brake is of the band type, and is brought into operation by lifting up a short lever on the outside of the conical casing. The lever releases a spring to apply the brake, the spring controlling the brake pressure quite independently of the pressure exerted on the lever.

As previously mentioned, the possible applications of the machine are extremely numerous, but one which is of considerable interest to power-station engineers is illustrated in Fig. 8 on page 230. This illustration shows a portable, electrically-driven centrifugal machine of the Sharples type connected up to the lubrication system of 5,000 kw. British Thomson-Houston turbo-generator in the Norwich power station, where it is employed for separating water and dirt from the oil. A small electrically-driven pump draws the contaminated oil from the turbo-generator, delivers it to the centrifugal and returns the purified oil to the system after treatment, the dirt being retained in the bowl and the separated water being automatically discharged and conveyed into any convenient drain. This operation can be

carried out while the generator is on load. Portable plants, similar to that illustrated in Fig. 8, are also used for removing water and carbon particles from the insulating oil used in large electrical transformers, the original dielectric strength of the oil being restored by passing it once through the centrifugal machine. Another interesting application is the purification of the fuel and lubricating oils on motor ships, and an installation of this class fitted on the M.S. Pacific Trader is illustrated in Fig. 9. One of the machines shown is normally employed for treating the fuel oil and the other for dealing with the lubricating oil, but the piping is so arranged that either machine, or both of them, can be used for either purpose if required. The fuel oil can be purified by one machine at the rate of from 1 to 2 tons per hour, according to the character of the impurities, while the rate of treating lubricating oil ranges from about 400 to 500 gallons per hour.

Fig. 10 shows a steam-driven machine installed at the Acton repair shops of the London Electric Railways, which were fully described in our issues of February 15 and 22, 1924, on pages 195 and 229. The machine is used there for recovering the oil from the soda solution used for washing the carriage underframes, &c. In the manufacture of varnish the Sharples machine has been successfully employed for the removal of solid extraneous matter, known as "foots," from the freshly manufactured material, which is passed through the machine at from 50 to 250 gallons per hour, according to circumstances. By its use, we understand, the product is improved and the ageing process, which normally occupies a period of from 12 to 18 months, can be halved, which is obviously a very important economic consideration. The treatment of the settlings from the bottoms of petroleum tanks, known in the trade as "B.S.," affords another instance of the utility of the super-centrifugal machine. These settlings take the form of an emulsion of about equal parts of oil and water which are particularly troublesome to separate by the usual means and are consequently difficult to dispose of. They can, however, be separated in the machine described above, the oil being recovered and utilised and the comparatively clean water being discharged to waste.

The above-mentioned examples by no means cover the whole of the possible applications of the machine, although they should be sufficient to give a general idea of its uses. One other application may, however, be referred to in conclusion, viz., the purification of the benzine used in dry-cleaning processes. The purification is effected in a continuous operation, the benzine being drawn from the washing machine, passed through the centrifugal and returned to the washer in a closed circuit; the comparatively small proportion of dirt collected in the bowl of the centrifugal is removed by hand occasionally. About 1,000 gallons of benzine per hour can be purified in this way by one centrifugal machine, which would be sufficient to keep two or three washing machines, of the size usually employed for this class work, in full operation. It is claimed that by constantly removing the dirt from the benzine the time required for the cleaning process is greatly reduced and also that a considerable saving is effected in the quantity of benzine used.

## NEW MESSAGERIES MARITIMES STEAMERS.

The Société Provençale de Constructions Navales recently launched from their La Ciotat yard on the Mediterranean the passenger steamer Mariette Pacha, which they are building for the Messageries Maritimes, for service between European ports and Egypt. This is a sister-ship to the Champollion, which was launched a few months ago and is being completed by the same company, also for the Messageries Maritimes. The principal dimensions of the ships are the following: Length between perpendiculars, 150 m. (492 ft.); length overall, 156·70 m. (514 ft.); breadth, 19·17 m. (63 ft.); depth, 13·36 m. (44 ft.); draught loaded, 8 m. (26 ft. 3 in.); displacement at 8 m. draught, 15,100 tons; deadweight carrying capacity, 6,360 tons. Accommodation is provided for 10 passengers in suites, 178 first-class passengers, 133 second-class, 128 second-class "intermediate," and 500 fourth-class passengers. The propelling machinery consists of two triple-expansion engines developing together 11,000 i.h.p., using steam superheated to about 280 deg. C., and having cylinders 760 mm. (30 in.), 1,250 mm. (49·22 in.) and 2,150 mm. (84·65 in.) in diameter, with a 1,350 mm. (53·15-in.) stroke. Their speed in normal service will be 90 r.p.m. and 95 r.p.m. under full-power trial conditions. Similar engines are fitted in the sister-ship above referred to, and are being also fitted in the steamer D'Artagnan, now in course of construction at the Chantiers et Ateliers de la Gironde, Bordeaux, for the same company. The engines are supplied with steam from seven marine, cylindrical, return-flue boilers of the Prudhon-Capus type, now largely used in the French merchant marine, and built by the Chantiers Navals et Chaudronneries du Midi, Marseilles. The principal dimensions of the boilers are as follows: Outside diameter, 5·41 m. (17 ft. 9 in.); total outside length, 3·82 m. (12 ft. 6 in.); total heating surface, 357 sq. m. (3,844 sq. ft.); grate area, fitted with grate for coal-firing, 7·57 sq. m. (81·5 sq. ft.); working pressure, 15 kg. per sq. cm. (213 lb. per square inch). Normally the boilers will be fired with oil fuel, but means are provided for transforming them rapidly for coal-firing. The superheaters are of the Schmidt type, and the boilers are supplied with air by Howden forced-draught fans, two in number, driven by steam. The liquid fuel is supplied to the boilers by two sets of Wallsend pumps, one set being sufficient for full service requirements under normal running conditions of the main engines. These latter have been designed to give the ship a speed of 16·5 knots under trial conditions.

## BOOKS RECEIVED.

*United States Coast and Geodetic Survey.* Special Publication No. 101. *Precise Triangulation, Traverse, and Levelling in North Carolina.* By W. D. Sutcliffe and H. G. Avers. [Price 25 cents.] Washington: Government Printing Office.

*United States Bureau of Standards.* Miscellaneous Publications No. 60. *Annual Report of Director, Year ended June* 30, 1924. Washington: Government Printing Office.

*Aeronautical Research Committee.* Reports and Memoranda. No. 926. *P.5 Flying Boat N.86 Impact Tests (Experiments with Full-Size Machines, Third Series).* [Price 6*d.* net.] No. 927. *The Characteristics of Thick Aerofoils.* By H. Glauert. [Price 2*d.* net.] London: His Majesty's Stationery Office.

*Transactions of the American Society of Civil Engineers. Vol. LXXXVII.* 1924. Edited by the Secretary, New York: Offices of the Society. [Price 12 dols.]

*Aeronautical Research Committee.* Reports and Memoranda. No. 925. *An Improved Model of Optical Indicator.* By W. J. Stern, B.Sc., and H. Moss, D.Sc. [Price 1*s.* 6*d.* net.] No. 931. *The Friction of Pistons and Piston Rings.* By T. E. Stanton, D.Sc., F.R.S. [Price 4*d.* net.] London: His Majesty's Stationery Office.

*The Journal of the Iron and Steel Institute. Vol. CX.* 1924. Edited by George C. Lloyd. London: Offices of the Institute and E. and F. N. Spon, Limited.

*Untersuchungen über die Gas-und Ol-gleichdruckturbine.* By Wilh Geutsch. Halle (Saale): Wilhelm Knapp. [Price 5·20 marks.]

*Elektrochemie und ihre Physikalisch-Chemischen Grundlagen. I. Allgemeine Elektrochemie.* By Dr. Heinrich Danneel. Berlin and Leipzig: Walter de Gruyter and Co. [Price 1·25 marks.]

*Junior Technical Electricity.* By Robert W. Hutchinson, M.Sc. London: University Tutorial Press, Limited. [Price 4*s.* 6*d.* net.]

*Radio, Beam and Broadcast: Its Story and Patents.* By A. H. Morse. London: Ernest Benn, Limited. [Price 12*s.* 6*d.* net.]

*The History of Munitions Supply in Canada,* 1914-1918. By David Carnegie, M.Inst.C.E. London: Longmans Green and Co. [Price 18*s.* net.]

*Eisenlahnzug-Telephonie.* By Difl Ing Bruno Rosenbaum. Berlin: M. Krayn. [Price 1·50 marks.]

*United States Public Health Service.* Bulletin No. 143. *A Study of the Pollution and Natural Purification of the Ohio River. II. Report on Surveys and Laboratory Studies.* Washington: Government Printing Office. [Price 60 cents.]

*A Textbook of Glass Technology.* By F. W. Hodkin, B.Sc., A.I.C., and A. Cousen, M.Sc. London: Constable and Co., Limited. [Price 42*s.* net.]

*The Mechanical World Electrical Pocket Book,* 1925. Manchester and London: Emmott and Co., Limited. [Price 1*s.* 6*d.* net.]

*The Journal of the Institute of Metals. Vol. XXXII.* 1924. Edited by G. Shaw Scott, M.Sc. London: Offices of the Institute. [Price 31*s.* 6*d.* net.]

*History of the Portland Cement Industry in the United States.* By Robert W. Lesley. New York and London: International Trade Press. Inc.

*The Slide Rule and its Application in Office, Foundry, Factory, and Mill.* By A. Williams Price. Birmingham: Cornish Brothers, Limited. [Price 3*s.* 6*d.* net.]

Personal.—Messrs. Thompson Brothers (Bilston), Limited, of Bradley Boiler and Engineering Works, Bilston, have recently opened an office at Aldwych House, Aldwych, London, W.C.2, for the transaction of business in connection with their galvanising plant, welded oil tanks, and steel plate work.—The Still Engine Company, Limited, have removed their offices from 7, Princes-street, Westminster, London, S.W.1, to Church Wharf, Chiswick, London, W.4.—The Hotchkiss Hydraulic Propeller Company, Limited, have concluded an agreement whereby the manufacturing and selling rights of the Hotchkiss propeller for Japan have been acquired by Mr. Tatsubo, of Messrs. Chihaya Shokai, Limited, Osaka, Japan.—Messrs. Evrard Havenith, iron and steel merchants, of Antwerp, have appointed Messrs. H. Stockwell and Co., of 10, Corporation-street, Manchester, as sole British selling agents for their products.

## NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

*Iron and Steel.*—The position in the engineering and steel trades has undergone little change as compared with a week ago. Prospects of revival, judging from current experience, appear to have been over-rated, and, so far as the staple industries confined to Sheffield are concerned, extreme difficulty is found in reducing the total of unemployed below the 20,000 mark. Indeed some firms are worse placed than was the case at the end of last year, and are able to supply the bulk of requirements from stock. The market for raw and semi-finished material reveals the existence of an extremely cautious attitude among all classes of buyers. Recent expansion in purchases has proved to be only temporary, and supplies of hematites and various grades of iron received at local works are mostly limited to the covering of immediate needs. On the whole, quotations show a weakening tendency, though so far as official rates are concerned, these are nominally unchanged, ruling as follow: West Coast hematites, 5*l.* 5*s.*; East Coast hematites, 4*l.* 10*s.*; Lincolnshire No. 3 foundry iron, 4*l.* 5*s.*; Lincolnshire forge, 4*l.*; Derbyshire No. 3 foundry, 4*l.* 2*s.* 6*d.*; Derbyshire forge, 3*l.* 17*s.* 6*d.*; bars, 13*l.*; sheets, 15*l.*—in each case per ton delivered at local works. Reports received from other districts indicate a diminution in foreign competition in iron and steel, attributed chiefly to rising costs and pressure on output at Continental works. Local producers, however, appear to have derived little benefit from this development. Competition for the limited amount of business passing is still so keen that prices continue barely remunerative, especially when these have to carry a deadweight of costs arising from the maintenance of idle plant. Except where benefit has accrued from railway contracts placed on home account, most of the big steel firms are struggling hard to maintain even the limited measure of prosperity enjoyed up to a month ago. More acid steel is going into consumption in connection with transport schemes, one large furnace having been converted from the production of basic steel to meet this development. The lighter trades are doing moderately well, though conditions are extraordinarily mixed, and while a few of the more favoured concerns are working full time, the majority could comfortably handle a much heavier output. A falling off in files and saws is, to some extent, compensated by an improvement in farm and garden tools, sheep shears and cutters.

*South Yorkshire Coal Trade.*—In face of the continued shrinkage in the export demand, difficulty is experienced in maintaining steam coal quotations at their recent level. Railway company orders are the collieries' main asset, and, fortunately, requirements under this head are very substantial. Moreover, the demand for cobbles, nuts and slacks shows a welcome expansion. Stocks are largely being cleared, current prices showing an average advance of from 9*d.* to 1*s.* a ton. Coke of all descriptions is weak, with prices in favour of buyers. Movement in house coal is mainly confined to best qualities, supplies of inferior grades being more than equal to the demand. Quotations:—Best branch handpicked, 30*s.* to 33*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 26*s.* to 31*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 19*s.* 6*d.* to 23*s.*; Derbyshire hards, 19*s.* 6*d.* to 22*s.*; rough slacks, 10*s.* to 12*s.* 6*d.*; nutty slacks, 9*s.* to 10*s.* 6*d.*; smalls, 4*s.* to 6*s.* 6*d.*

## NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

*The Cleveland Iron Trade.*—Cleveland pig-iron is not at all plentiful, but customers experience no difficulty in satisfying their needs, and unless demand improves or output is reduced, accumulation of stocks is threatened. A mishap has put a furnace of Messrs. Bolckow, Vaughan and Co. out of operation, but the firm are rekindling another in its place. Home needs are fairly heavy and hopes of rather better sales to the Continent are expressed, whilst America is buying special iron usually taken by that country, and is also inquiring a little for ordinary foundry grades. No. 1 Cleveland pig is 83*s.* 6*d.*; No. 3 g.m.b., 78*s.* 6*d.*; No. 4 foundry, 77*s.* 6*d.*; and No. 4 forge, 76*s.* 6*d.*

*Hematite.*—Notwithstanding its far from satisfactory statistical state, the hematite branch keeps fairly steady. Producers, however, whilst adhering to quotations, are very anxious to secure contracts, and buyers with orders to place endeavour to shade recognised market rates. One or two Continental and American inquiries are reported, but overseas sales are difficult to arrange. Nos. 1, 2 and 3 are put at 86*s.*, and No. 1 is quoted 6*d.* above mixed numbers.

*Foreign Ore.*—Transactions in foreign ore are few and small. Sellers base market quotations on best rubio at 22*s.* 6*d.* c.i.f. Tees, but consumers express the belief that contracts might be made on substantially lower terms.

*Manufactured Iron and Steel.*—There is no new feature in the manufactured iron trade. As regards semi-finished steel, producers are understood to have sold fair quantities by cutting prices. Inquiries for finished steel are slightly better, but actual sales are far from extensive. Principal market quotations stand:—Common iron bars, 12*l.*; iron rivets, 14*l.* 5*s.*; packing (parallel), 8*l.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel ship, bridge and tank plates, 9*l.* 5*s.*; steel angles, 9*l.*; heavy steel rails, 9*l.* 5*s.* to 9*l.* 10*s.*; and galvanised corrugated sheets (24-in. gauge, in bundles), 17*l.* 5*s.*

## NOTES FROM THE NORTH.

GLASGOW, Wednesday.

*Scottish Steel Trade.*—No change has taken place this week in the steel trade of Scotland, and producers are finding it very difficult to carry on. The scarcity of new business is very marked, and as there is still a goodly quantity of Continental material available, the local makers are not having much chance. Competition from the latter source is, perhaps, not quite so persistent as prices have firmed up a bit, but it is, nevertheless, still something to be reckoned with. The placing of one or two shipbuilding contracts recently has given a slightly better outlook, but the tonnage of steel required may not be of any great consequence. Inquiries are not at all encouraging either for home requirements or for export. The black-sheet trade is unchanged also, but active conditions continue all round. The demand for galvanised sheets is again quite good, and order-books are well filled forward. Heavy-gauge sheets are slow. Prices are keeping fairly steady despite prevailing conditions, and are quoted as follow:—Boiler plates, 13*l.* per ton; ship plates, 9*l.* 15*s.* per ton; sections, 9*l.* 10*s.* per ton; and sheets, $\frac{3}{16}$ to $\frac{1}{2}$ in., 12*l.* per ton, all delivered Glasgow stations.

*Malleable Iron Trade.*—The malleable iron makers of the West of Scotland are no better off for orders, and business is very stiff. Consumers are not in the position to place much at present, and hand-to-mouth conditions prevail. In the steel re-rolling departments there is a fair turn of work, but very keen prices have to be taken to secure anything on offer. The current price for "Crown" bars is 12*l.* per ton, delivered Glasgow stations.

*Scottish Pig-Iron Trade.*—The Scottish pig-iron trade is not in a very flourishing state at the present time. The reduction in output—referred to last week—may have the effect of steadying things a bit, but that is doubtful as stocks all round are heavy and consumption small. The export trade, which was once such an asset, is now only a shadow, and overseas buyers would seem to be buying very little iron, otherwise the local makers would seem to be out of court meantime. The former is probably the more likely state of affairs. Inquiries this week are few. Prices mark no change from last week and are as follow:—Hematite, 4*l.* 13*s.* 6*d.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 11*s.* 6*d.* per ton, and No. 3, 4*l.* 9*s.* per ton, both on trucks at makers' yards.

*Scottish Pig-Iron Shipments.*—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, February 14, amounted to 734 tons. Of that total 696 tons went overseas and 38 tons coastwise. For the corresponding week of last year the figures were 694 tons overseas and 22 tons coastwise, making a total shipment of 716 tons.

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CHADWICK LECTURES.—The 1925 Spring Programme of Chadwick Public Lectures includes an address to be given, on Monday, March 9, by Lord Newton, on "The Necessity for Legislation with Regard to Smoke Abatement." In May, Dr. Brumpt, Professor of Medicine at the University of Paris, will deliver two lectures, one being entitled "How to Conduct an Anti-Malarial Campaign." Other discourses have been arranged, further information regarding which may be obtained from the Secretary, Mrs. Aubrey Richardson, at the offices of the Trust, 13, Great George-street, Westminster, London, S.W.

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CONTRACTS.—Messrs. Ed. Bennis and Co., Limited, of 28, Victoria-street, Westminster, London, S.W.1, have recently received orders from Nixon's Navigation Company, Limited, of Merthyr Vale, for a complete mechanical coal-handling equipment, including a Bennis U-link chain conveyor and coal elevator, to serve an installation of 19 Lancashire boilers. A contract has been secured from the City of Sheffield Electrical Supply Department for six chain-grate stokers for three Stirling water-tube boilers. Further, the company are undertaking the complete equipment of six Lancashire boilers for the new works at Wolverhampton of Messrs. Courtaulds, Limited, of Foleshill-road, Coventry, with Bennis sprinkler stokers, compressed-air furnaces, coal storage bunkers, and U-link conveyors for the mechanical handling of coal and ashes.—Messrs. Vickers Limited, have secured a contract for four low-temperature long-fusion rotary retorts, each 4 ft. in diameter and 50 ft. long, to be installed at the Burghlee Colliery at Loanhead, Midlothian. This plant was selected by Messrs. W. Hunter and Sons, consulting engineers, Edinburgh, and will work on waste coal for the purpose of obtaining oil and other products.—Messrs. Howden-Ljungström Preheaters (Land), Limited, of 133, Helen-street, Govan, Glasgow, have delivered four large air preheaters to Messrs. Caldwells Paper Mills, Inverkeithing.—Messrs. H. R. Marsden, Limited, of Soho Foundry, Meadow-road, Leeds, have recently secured contracts for complete breaking, screening and quarry plant from the Ross and Cromarty Council, Dingwall, and for breaking, screening and tar-macadam plant from the Berwickshire and the Kirkcudbright County Councils.—Messrs. John Thompson Water-tube Boilers, Limited, of Imperial House, Kingsway, London, W.C.2, have received a repeat order from The Isle of Thanet Electrical Supply Company, Limited, St. Peters, Kent, for a vertical straight tube type boiler with superheater and feed pumps, &c.—An order for over 1,000 tons of steel required for the framework of the paper mill of the Wayagmack News, Limited, to be built at Quebec, Canada, has been secured by Messrs. John Booth and Sons, of Hulton Steelworks, Bolton. It is of interest to note that the entire consignment is required to be shipped within twelve weeks.

## NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

*The Coal Trade.*—In January 1,928,856 tons of coal were exported from the four principal South Wales ports of Cardiff, Newport, Port Talbot, and Swansea, which was 194,242 tons less than that dealt with in December when work was interrupted by holidays. The volume of trade in January was only lower in June last during the past two years. The revenue derived from coal shipments in the past month at 2,306,917*l.* was the smallest for any month in the past two years, and when compared with December showed a reduction of 254,644*l.* The average price per ton in January at 23*s.* 11*d.* f.o.b. was 2*d.* less than in December. Shipments from the different ports in January were as follows:—

| From | Tons. | £ | Per Ton. s. | d. |
|---|---|---|---|---|
| Cardiff ... | 1,126,031 | 1,322,880 | 23 | 6 |
| Newport ... | 422,130 | 487,166 | 23 | 1 |
| Port Talbot | 144,881 | 167,995 | 23 | 2 |
| Swansea ... | 235,814 | 328,876 | 27 | 11 |
| Totals | 1,928,856 | 2,306,917 | 23 | 11 |

Coal shipped from Cardiff was reduced by 1*d.* per ton compared with December, at Newport by 3*d.*, and at Swansea by 2*s.* 1*d.*, but at Port Talbot was increased by 1*s.* 5*d.* In January 622,858 tons of small coal was exported valued at 547,448*l.*, or 17*s.* 7*d.* per ton, which was 4*d.* per ton less than in December, 38,571 tons of through valued at 38,765*l.*, or 20*s.* 1*d.* per ton, a decrease of 11*d.*; and 1,267,427 tons of large valued at 1,720,704*l.*, or 27*s.* 2*d.* per ton, a fall of 1*d.* per ton. Anthracite coal shipped from Swansea totalled 166,998 tons, an increase of 8,637 tons, but the value at 261,537*l.* showed a reduction of 16,420*l.*, and the average price at 31*s.* 4*d.*, a drop of 3*s.* 9*d.* per ton.

*New Pitwood Agreement.*—Some time ago the South Wales colliery owners complained to the pitwood importers of the quality of the wood which was being supplied for timbering purposes. The importers in reply intimated that representations had been made on the matter to the exporters on the other side, and that steps were being taken in regard to the question. Since then negotiations have proceeded between the Cardiff and Bristol Channel Pitwood Importers' Association and the Bordeaux Syndicate of Pitwood Exporters, and a new agreement for the sale and purchase of pitwood has been agreed in place of the agreement made in 1911. In the new agreement, which was ratified by the South Wales importers on Tuesday, it is stipulated that the Bordeaux exporters are only to send wood which is absolutely suitable for colliery purposes, and that the dimensions are to be as follows: 6½-ft. lengths are to be 3½ in. to 8 in. in diameter at the small end under the bark, 9-ft. lengths 5 in. to 10 in. in diameter, and 13-ft. lengths 8 in. to 17 in. in diameter. Payments are to be effected without discount three-fourths against documents and the balance after discharge, but not later than 20 days after the ships' departure from loading port. In the event of new export taxes being imposed the same shall be, if the seller requires, borne by the buyer, but the buyer shall have the option of cancelling the purchase. Sales are made f.o.b. on the weight delivered in this country as per the certificate of the dock company in the Bristol Channel without any deduction for wastage, weighing to be effected at buyer's expense.

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ANODIC SOLUTION OF GOLD BY ALTERNATING CURRENTS SUPERPOSED UPON DIRECT CURRENTS.—Electrolysis by alternating currents is possible although the effect of one impulse is generally counteracted by the next impulse. In 1903 R. Ruer observed in Göttingen that platinum would dissolve in diluted sulphuric acid (in which it is otherwise insoluble) when it was made simultaneously anode of two independent circuits, one D.C., the other A.C., and he studied the influences of the ratio of A.C. to D.C., of current densities, concentration, &c. The superposition of A.C. on D.C. has since then often been resorted to in laboratories, but it seems to have found technical utilisation only in the separation of gold and silver by the process of Wohlwill (Hamburg) which has been adopted in many works. Wohlwill first electrolysed the gold-silver anode in an excess of hydrochloric acid by direct currents, but he could then apply only a low current density because a film of silver chloride formed on the anode and stopped the solution of gold, while chlorine was liberated. Superposing A.C. on the D.C. he could use a much higher current density without being troubled by solid films and could work with lower potentials. An investigation of these reactions was communicated by Dr. A. J. Allmand and Mr. V. S. Puri, of King's College, to the Faraday Society on the 16th inst. Working with anodes merely of gold Dr. Allmand found that, when the current density was raised too high the gold became passive and did not dissolve any more, while the potential rose, and he ascribed this passivity to the formation of a gold-oxygen alloy. The "activity" limit rose with increased acid concentration, temperature, the ratio of A.C. to D.C. and frequency, whilst the solution potential of gold was the lower, the higher the A.C. : D.C. ratio and the lower the frequency, and the initial potential of chlorine evolution was the greater the lower the A.C. : D.C. ratio and the lower the acid concentration. Dr. Allmand accounted for some of the complex reactions, but not for the influence of frequency. The various reactions take some, though very little time; absorption, diffusion and other factors enter, and it is very difficult to separate the effects.

## NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—To-night at 6 p.m., at Storey's-gate, S.W.1. Annual General Meeting. Adjourned discussion on "Anti-Friction Bearing Applications for Heavy Duty." By Mr. J. B. Dahlerus. Friday, February 27, at 7 p.m. Informal Meeting. Discussion on "Practical Problems of Lubrication."

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—To-night at 6.30 p.m., at the University College, Gower-street, W.C.1. Instead of at the Engineers' Club, Coventry-street, W.1. Lecture, "Photo-Elastic Methods of Measuring Stress." By Professor E. G. Coker, F.R.S.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night at 7.30 p.m., at 39, Victoria-street, S.W.1. Lecturette, "Inverted Tooth Chain Drives." By Mr. J. M. Seddon. Friday, February 27, at 7.30 p.m. Lecturette, "A Treatise on Modern Lighting Practice." By Mr. E. Stroud.

THE INSTITUTION OF PRODUCTION ENGINEERS.—To-night at 7.30 p.m., at the Society of Motor Manufacturers and Traders, 83, Pall-mall, S.W.1. "Grinding Practice." By Mr. H. A. Dean.

THE INSTITUTION OF ENGINEERING INSPECTION.—To-night at 7.45, at the Royal Society of Arts, John-street, Adelphi, W.C.2. "The Radium Industry: Its Development and Importance." By Major Charles E. S. Phillips, F.R.S.E.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: YORKSHIRE DISTRICT. Saturday, February 21, at 2 p.m., at the Guildhall, Hull. "Tramway Construction." By Mr. A. R. Hills.

THE SCIENTIFIC SOCIETY OF THE ROYAL TECHNICAL COLLEGE.—Saturday, February 21, at 7.30 p.m., at the Royal Technical College, George-street, Glasgow. "The Double-acting Two-stroke Diesel." By Mr. J. C. MacLagan.

THE ROYAL SOCIETY OF ARTS.—Monday, February 23, at 8 p.m., at John-street, Adelphi, W.C.2. Cantor Lectures. "The Inner Structure of Alloys" (Lecture II.). By Dr. Walter Rosenhain, F.R.S. Tuesday, February 24, at 4.30 p.m. Dominions and Colonies Section. "Transport in Tropical Africa." By Mr. R. H. Brackenbury. Wednesday, February 25, at 8 p.m. Ordinary Meeting. "The Power of Internal Combustion Engines for Motor Cars." By Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 24, at 6 p.m., at Great George-street, S.W.1. Ordinary Meeting. Paper to be submitted for discussion, "The Demolition of the Harbour and Defence Works of Heligoland." By Mr. Leopold Halliday Saville, M.Inst.C.E. Saturday, February 28. Students' visit to Messrs. Harland and Wolff's shops, King George V Dock.

THE MANCHESTER METALLURGICAL SOCIETY.—Tuesday, February 24, at 7 p.m., at the College of Technology, Manchester. "Cast Iron." By Mr. J. G. Pearce, B.Sc.

THE INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Tuesday, February 24, at 7 p.m., at the Hotel Metropole, King-street, Leeds. "Selection of Ball and Roller Bearings for Electrical Machines." By Mr. T. D. Trees.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, February 24, at 7.30 p.m., at the Rankine Hall, 39, Elmbank-crescent, Glasgow. "The Latest Type of the Burmeister and Wain Marine Diesel Engine." By Mr. H. H. Blache.

THE INSTITUTION OF STRUCTURAL ENGINEERS.—Thursday, February 26, at 8 p.m., at Denison House, 296, Vauxhall Bridge-road, S.W.1. "Reinforced Concrete Columns." By Mr. Edward Godfrey.

THE MANCHESTER ASSOCIATION OF ENGINEERS.—Friday, February 27, at 7.15 p.m., at the Engineers' Club, Albert Square, Manchester. "The Internal Combustion Turbine." By Dr. T. B. Morley.

THE NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, February 27, at 7.30 p.m., in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne. "Ultimate Possibilities of Steam Plant." By Professor A. L. Mellanby, D.Sc., and Dr. William Kerr, Ph.D.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Friday, February 27, at 7.30 p.m., at Watergate House, Adelphi, W.C.2. London Graduates Meeting. "Why Pneumatic Tyres?" By Mr. R. Marks.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, February 27, at 9 p.m., at Albemarle-street, W.1. Evening discourse will be delivered by Sir James Irvine on "Sugars from the Standpoint of the Organic Chemist." Saturday, February 28, at 3 p.m. Afternoon Lecture. Sir Ernest Rutherford on "The Counting of the Atoms." (Lecture I.)

THE HULL ASSOCIATION OF ENGINEERS.—Saturday, February 28, at 7.15 p.m., at the Hull Technical College. Lecture. "Road Passenger Transport." By Mr. E. S. Rayner, M.I.E.E.

# SHARPLES CENTRIFUGAL SEPARATING MACHINES FOR LIQUIDS.

CONSTRUCTED BY SUPER-CENTRIFUGAL ENGINEERS, LIMITED, LONDON.

(*For Description, see Page* 226.)

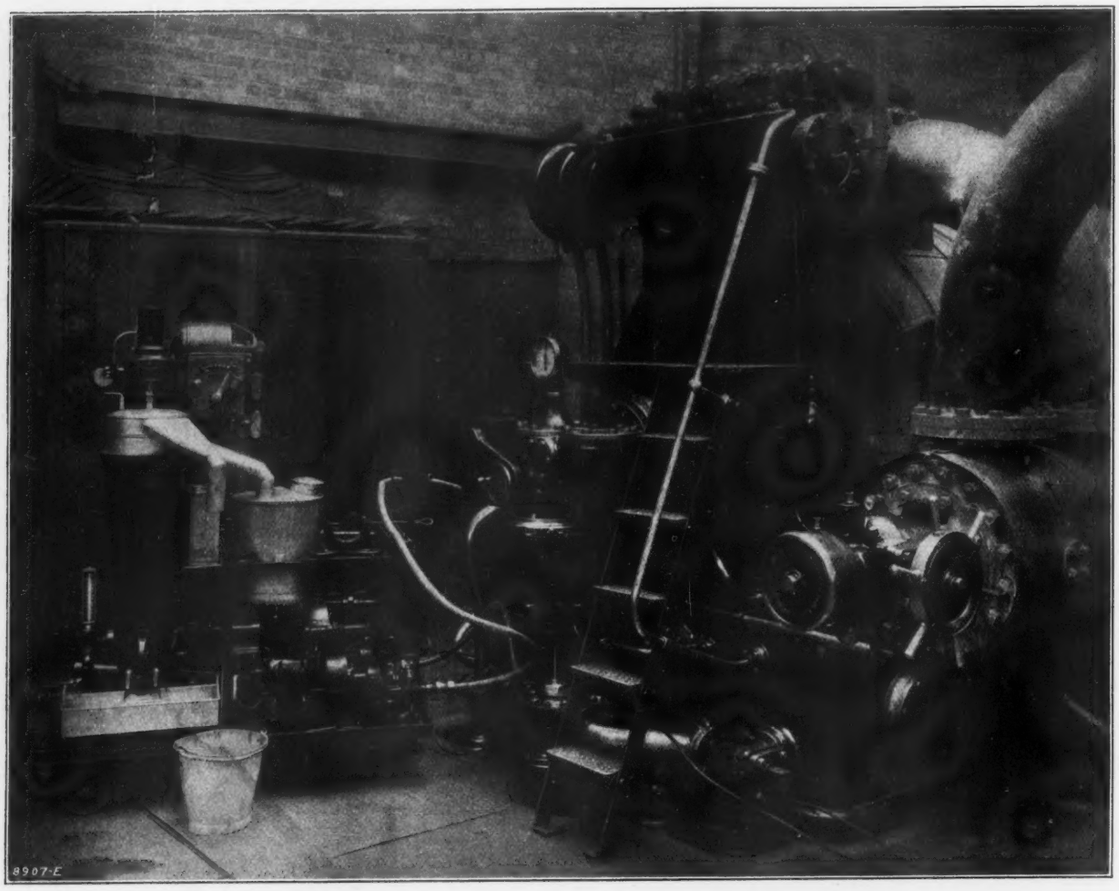



FIG. 8. PORTABLE MACHINE FOR TREATING TURBO-GENERATOR LUBRICATING OIL.

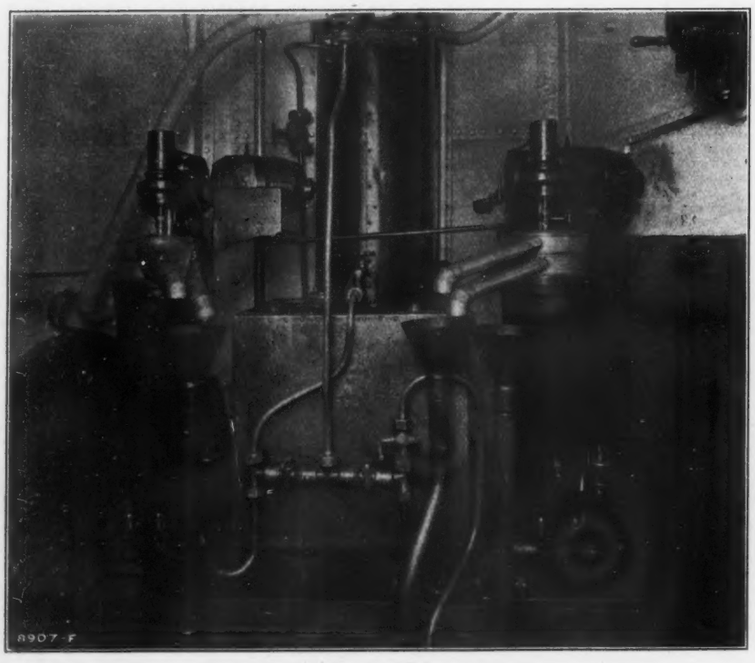



FIG. 9. INSTALLATION ON M.S. "PACIFIC TRADER," FOR PURIFYING FUEL AND LUBRICATING OILS.

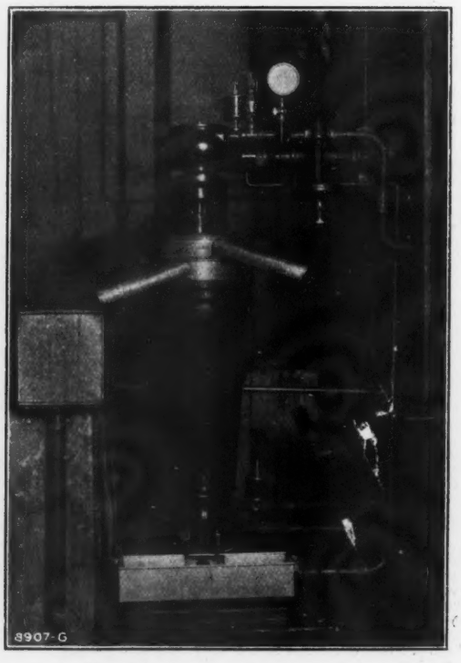



FIG. 10. MACHINE FOR RECOVERING OIL FROM SODA-WASH SOLUTION.

# THE 10-H.P. TRIUMPH

CONSTRUCTED BY THE TRIUMPH MOTOR COMPAN

(For Description, see P

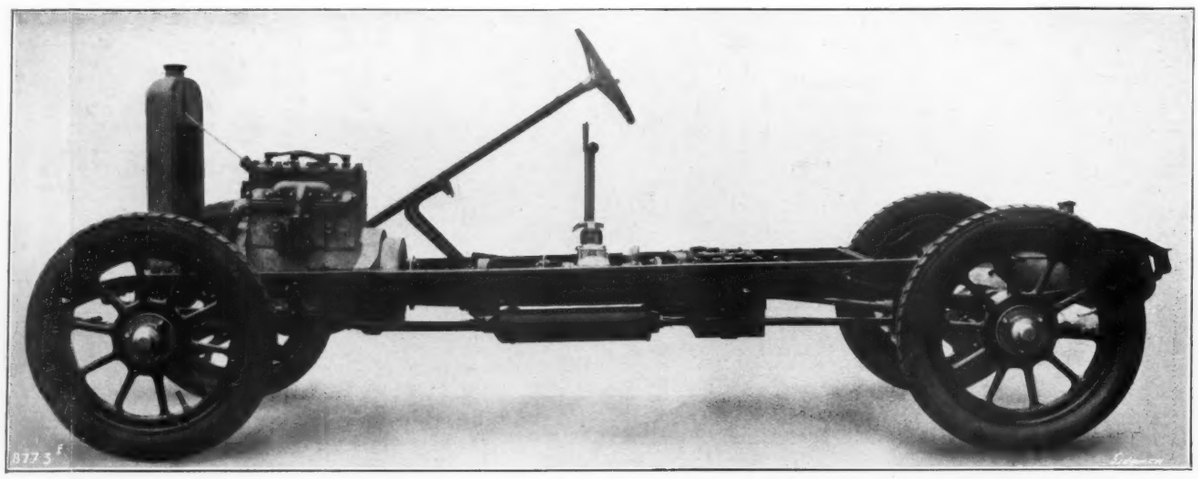


FIG. 1.

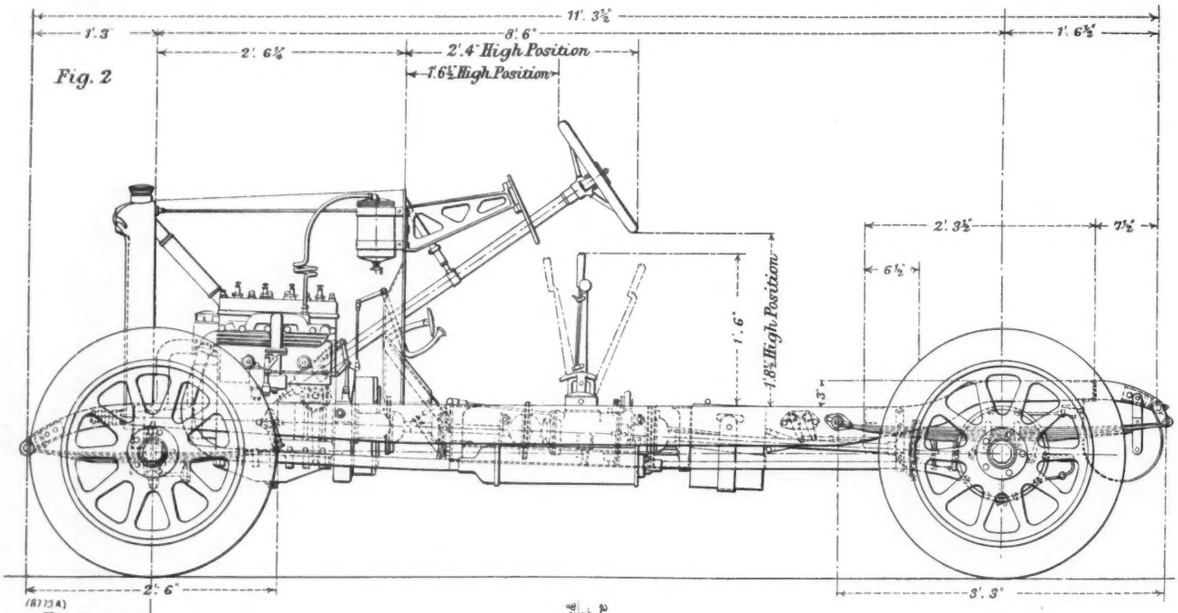



Fig. 2

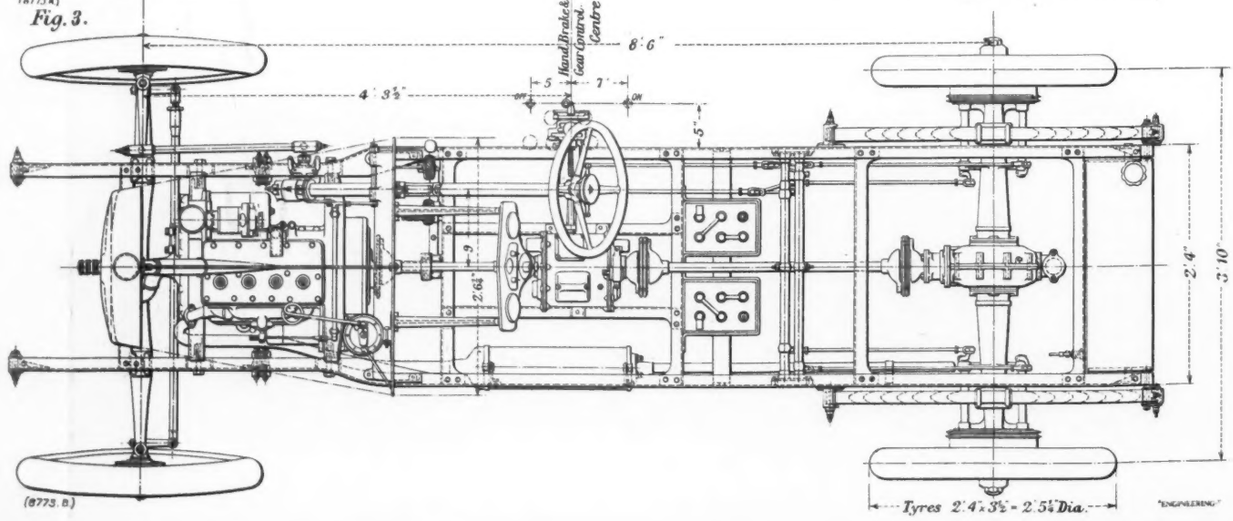



Fig. 3.

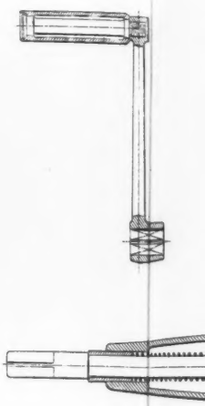


Fig. 4

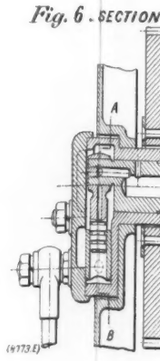



Fig. 6. SECTION

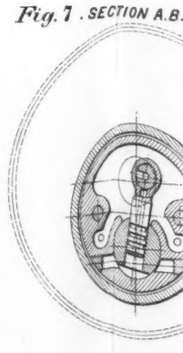


Fig. 7. SECTION A.B.

# TRIUMPH MOTOR CAR.

MOTOR COMPANY, LIMITED, ENGINEERS, COVENTRY.

(For Description, see Page 223.)

*Fig. 4.*

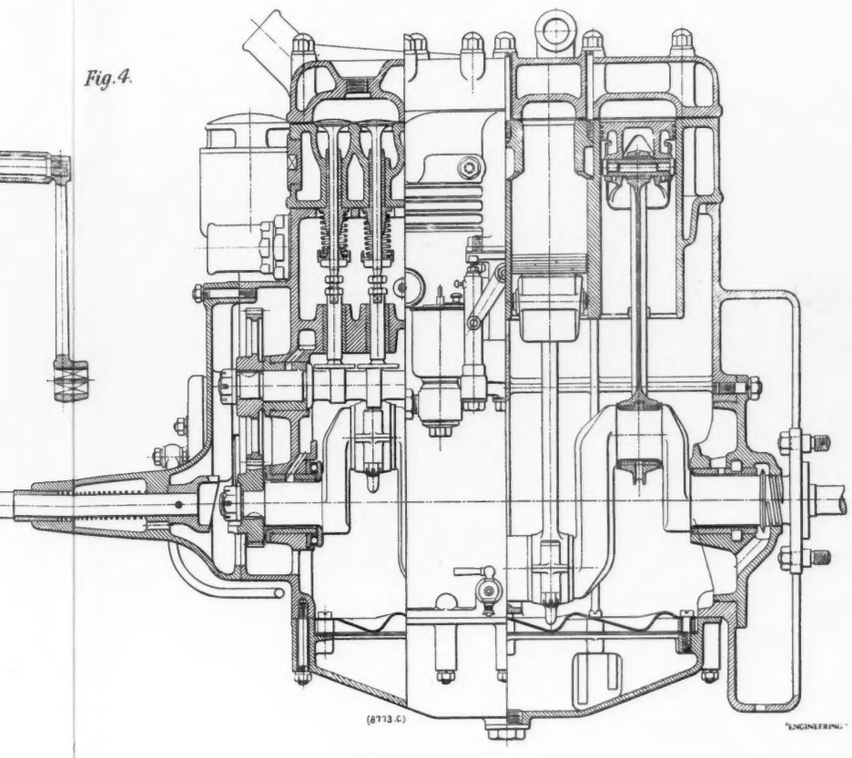



*Fig. 5.*

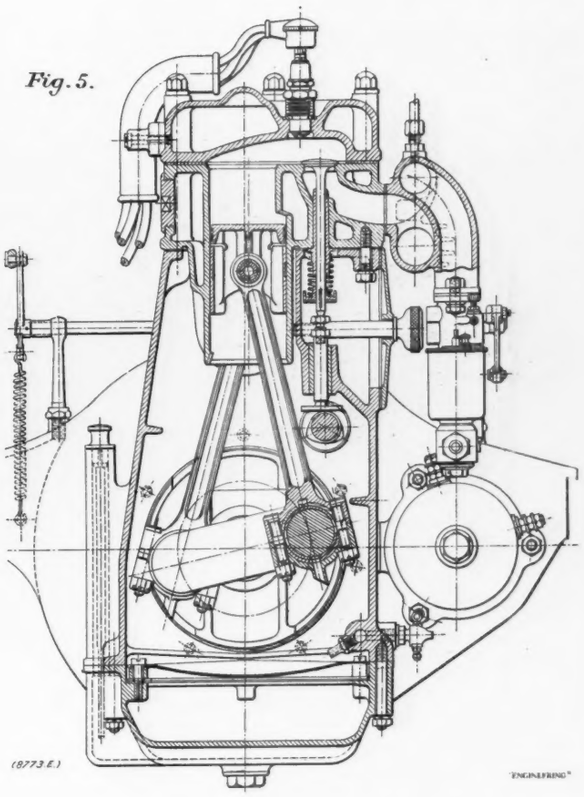



*Fig. 6.* SECTION OF PUMP.

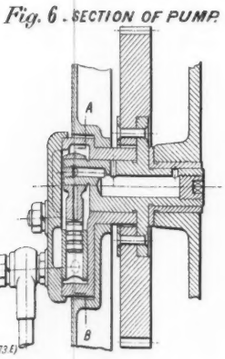



*Fig. 8.*
SECTION A.B.

*Fig. 9.*

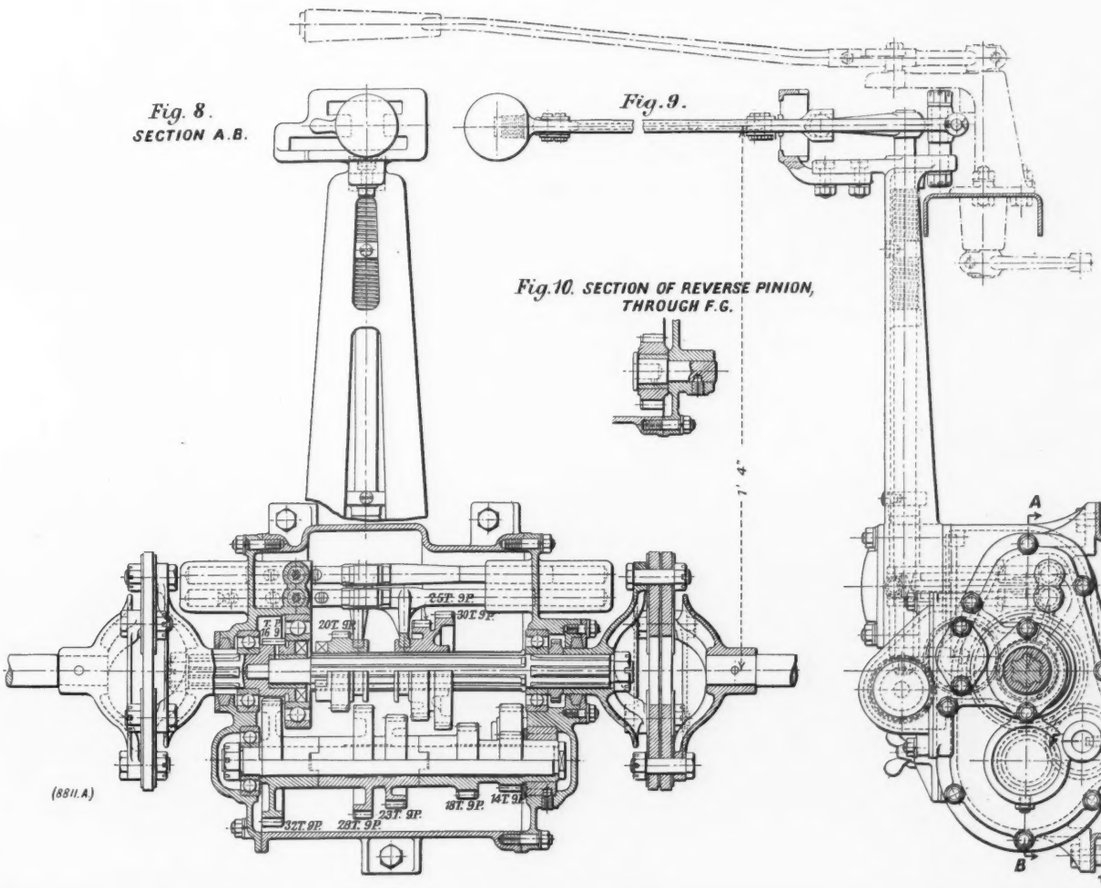
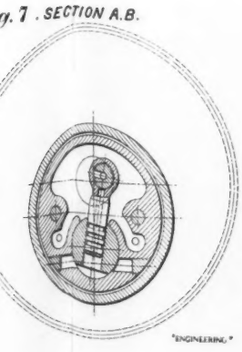



*Fig. 10.* SECTION OF REVERSE PINION, THROUGH F.G.



*Fig. 7.* SECTION A.B.



# ENGINEERING.

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# ENGINEERING.

*FRIDAY, FEBRUARY* 20, 1925.


## FREE TRADE IN ABILITY.

IN one of the most acceptable forms of presidential address the speaker deals with some professional topic in the light of his own personal experience. There is, indeed, no point in being addressed by a distinguished man if his discourse is merely a signed leading article. It should be at least as much in the nature of testimony as of exposition and criticism; and all these characteristics are agreeably present in Mr. L. A. Legros' presidential address to the British Section of the Société des Ingénieurs Civils de France, of which we begin an abstract in another column. The conclusions at which Mr. Legros arrives are for the most part familiar to engineers, and they owe their special interest in the present context to the fact that the most important of them are derived from his own immediate experience. During a period of forty years Mr. Legros' experience in the workshop, as well as in the laboratory and the study, has covered an unusual variety of trades, while during the war it included a period of service as Chief Dilution Officer, first at Birmingham for all trades, and then for aircraft over the whole country, and finally in the Ministry of National Service. This gave him excellent opportunity of seeing the inner working of the forces that influence labour, and which in their effects are met with in most engineers' shops.

The net outcome of his testimony on the present position of skilled and unskilled labour in its relation to production, does not differ substantially from that which has been presented more than once in these columns. From his own experience, as well as from a general survey of the history and position of labour in the engineering trades, he repeats the warning that the efficiency of these trades is being crippled by the denial of freedom to individual workers, and in particular of the freedom to trade in whatever abilities they possess. In two respects his warning goes further than most of those that have been given previously through other channels. While speaking with sympathy of trade unions and implying a profound belief in the useful part they could play in advancing the interests of the community, he denounces in much plainer terms than are usual the "black hand," the "cells," the "rays," and similar malign influences that during the war and afterwards have been striving to keep the minds of the workers unsettled and to restrict or reduce their production. If such efforts are ultimately successful, they will inevitably, in his opinion, not only prevent the recovery of the engineering trades from their present deplorable position. They will actually depress them still further by causing this country to lose international business to countries whose working men are advised more sanely, and the situation so created will compel wholesale emigration. He urges as an incidental provision for such a contingency, which would be useful in any event, that some manual skill should be taught as part of the curriculum in schools of all grades.

The other danger to which Mr. Legros calls attention with unusual emphasis is the probable insufficiency of the supply of really skilled labour. While an apprentice is procuring the training necessary for acquiring real skill, he occupies the time of skilled men in teaching him; he cannot for the time being give the works as much service as he could if he were doing less skilled work in which he was fully proficient, and he must therefore accept less wages. What he sacrifices in this way while he is serving his time is an investment, without which he cannot become a skilled man; and why, as Mr. Legros expresses it, should he elect to make this investment in the hope of becoming a fully qualified tradesman in a competitive trade at 56*s.* a week, when without any such sacrifice he may become a protected dustman at 80*s.*? The course of modern practice has been, and is, steadily tending to subdivide the processes of production, so as to bring each of them more and more within the ability of untrained or slightly trained workers. The economic advantage of this course was pointed out by Babbage as far back as 1832, long before it was adopted in practice on any appreciable scale. Such subdivision, in addition to the recognised efficiency of all practicable sub-division of labour, has the advantage that it reduces the number of kinds of skill or aptitude required in each individual. The difficulty of finding an individual with one particular aptitude is more than doubled when he must also possess second aptitude; and when, as with the skilled tradesman, each individual must combine many aptitudes, the difficulty of finding qualified individuals is multiplied by a much larger figure than the number of qualities each of them must possess. Modern industry, therefore, called upon unceasingly to improve the standard of living for a constantly growing population, and compelled to use every means by which the energies of its workers might yield a larger product, is subdividing its manufacturing operations so as to bring them more and more completely within the capacity of the largest number of available workers. Incidentally, this process, if allowed to go on without interference, provides employment for an increasing number of workers who have not been through an apprenticeship; but as the number of such unskilled workers increases, so does the number of the skilled men who are required to supervise them, and to perform the many skilled operations involved in keeping machinery at work. If they are not available, proportionately fewer unskilled men can be employed, and the industry, which, according to age-long experience, must lose ground if it does not gain it, will, in the vicious circle thus created, go from bad to worse.

Such is the course that Mr. Legros predicts will occur in the engineering trades if the energy of their workers is not restored to its full effectiveness, and if a sufficient supply of really skilled men is not assured. The success of agitators in depressing production, a success that has been greater in this than in any other civilised country, is due in his opinion to two main factors. On the one hand, they have control of the union machine; and by using for their own non-industrial purposes the abnormal privileges that Parliament provided

for what were represented as legitimate uses, they are able to create among the general body of trade unionists a unity of action that may appear to be *esprit de corps*, but is in reality a dread of being frozen out of employment if they oppose the dominant minority. On the other hand, they are able to make capital out of the delusion that continued employment is best assured by reducing each man's output. The short-sightedness of this view is well expressed in Mr. Legros' picture of a seaman steering to avoid ripples and being caught by a roller; but the image fails to represent how much nearer unemployment seems to a man than loss of markets.

Until the influences that pervert trade unions from their useful functions are sterilised by the reform of the present anomalous legislation relating to those bodies; until means are found to reduce the risk that men will lose their jobs more quickly as their production increases; and until really skilled men cease to be the "new poor" and receive a fair reward for the investment they made in acquiring their skill, the present situation will continue. Mr. Legros' principal remedies are to restore free trade in ability, and to pay the labourer the hire he is worth. The resulting improvement in trade should do much to reduce the difficulty of what is really the fundamental obstacle to industrial peace, the assurance of continued employment. With modern views of the duty of the employer, a duty which is likewise his interest, this difficulty is primarily his; but while no employer can be sure of overcoming it, many would find it easier if employment were freed from the absurd and arbitrary demarcations by which men, for whom one class of work is temporarily exhausted, are prevented from being put on to other work. A subsidiary suggestion of Mr. Legros'—that men should be rated for skill by a secret ballot within the union—seems to have less to commend it than others of his proposals. Up till now the classes of men whose skill is recognised in the community as needing to be certified by a central authority, are those who deal with matters that the laymen whom they serve are incompetent to assess. The workman does not come within that category. If his employer is not competent to assess a man's skill, he ought not to be an employer. A qualified employer would sooner take his own judgment of a man than accept the result of any sort of ballot; and an anonymous voter has no responsibility either for his individual vote or for the ultimate outcome of the ballot. But the main thesis that a man should be free in the engineering trades to use his abilities in whatever ways he can, and should earn whatever they are worth, will command the assent of all who are familiar with the needs of the trades and the real aspirations of those who work in them. An article on "Dutch Shipbuilding and Repairing," which appears elsewhere in this issue, would appear to show that the point of view for which Mr. Legros pleaded, is at least partly accepted and acted on in Holland.

## THE STABILITY OF ST. PAUL'S.

The official report published last Tuesday on the condition of St. Paul's Cathedral, is decidedly reassuring. The committee responsible for it was appointed in October, 1921, and have spent the intervening period in making a thorough examination of the structure. As was natural under the circumstances, a preponderating proportion of its members were engineers, since architects, nowadays lay little claim to be considered experts on questions of strength and stability, a condition of affairs which possibly provides the reason why they have of late taken so much pains to emphasise their artistic pretentions. However, that may be, three members of the committee, viz., Mr. Basil Mott, Mr. E. C. Trench and Mr. G. W. Humphreys, were engineers, the remaining members being Sir Aston Webb, who acted as chairman, and Mr. Mervyn E. Macartney, the architect in charge of the structure.

The committee have established the important fact that there has been no uneven settlement of recent date. This conclusion is the more important because Sir Francis Fox, from the more limited investigation he was able to make, had come to the conclusion that serious damage had been occasioned in 1831 by the attempt of the Corporation to construct a deep sewer through quicksands on the south side of the Cathedral. From the fuller information secured by the committee, it now appears that this conclusion was inaccurate, but the data given indicate how Sir Francis may have been misled. The lower part of the structure does indeed tilt towards the south-west, but the committee bring forward what appears to be convincing evidence, that the unequal settlement, responsible for this, occurred during the course of erection, and that there has been no unequal settlement since.

The subsoil, on which the building was founded, was not uniform, and hence, as more and more weight was added to the structure during the process of erection, it tilted, and to correct this, compensating courses were added from time to time as the work progressed. Such courses are found at the level of the main cornice, at the stone gallery, and at the level of the parapets adjoining the external drum. By the time the upper levels were reached, however, the foundations had consolidated, and to-day the base of the lantern is still horizontal, and its axis vertical.

The work of the committee in making these investigations was increased by the failure of past curators to provide permanent bench marks, which would have made practicable a direct comparison between the latest measurements and previous records. This omission has now been rectified, and a permanent bench mark established on a cast-iron shaft sunk into the London clay near the General Post Office. To further facilitate future comparisons, about 150 gun-metal sockets, designed to receive hardened steel plugs, have been fixed in different positions on the masonry. The committee recommend that new levels should be taken periodically.

One important conclusion reached is that little or no damage is attributable to vibration. It is, in fact, now well established that vibrations which appear quite alarming, have often only an extraordinarily small amplitude. The cracks found appear to have been occasioned by temperature changes, and measurements made of them show a regular cyclical variation with the season of the year. It is mainly to the cumulative effect of such temperature strains that the committee attribute the very considerable distortion of the drum below the dome, which measures $6\frac{3}{4}$ in. more across a N.-S. diameter than transversely. The "great chain," put in by Wren to take the horizontal thrust of the dome is nevertheless reported as being apparently sound, and further spreading of the drum is to be checked by metal rings surrounding it at two levels. As stated the distortion in question is attributed to the fact that the contraction of the structure during the winter has not perfectly annulled the expansion due to summer heat, so that there has been a cumulative, but very slow, creeping or spreading of the masonry during the centuries subsequent to erection. The annual range of variation in the diameter is very small, being estimated at $\frac{1}{16}$ in., but as the measurements were made with invar wires, they may be confidently relied on.

Other observations show that the changes of temperature are responsible for an oscillation of about $\frac{1}{8}$ in. in the position of the top of the cone. The tops of the piers also show a slight annual oscillation, but the amplitude is small. Temperature changes are also held responsible for the cracks in the radial walls between the two drums. The report refers also to the shattered condition of the masonry of some of the 32 buttresses placed round the outer periphery of the peristyle. These buttresses do not, however, play any important part in distributing the load, and the committee express the opinion that it is undesirable that they should do so.

The report gives the following estimates of the weight of the structure as taken out by Mr. J. D. Drower, F.S.I.:—The total weight of the dome, its drum and peristyle, the buttresses surrounding it, the eight piers supporting it, and the eight great arches, together with those portions of the walls and vaults of the choir, nave, transepts, and aisles carried by the piers and bastions, may be summarised as follows:—

| | Tons. |
|---|---|
| (1) Total from top of cross to top of keys of great arches ... ... ... | 23,098 |
| From top of keys of great arches to top of plinth, 4 ft. 2 in. above church floor level ... ... ... | 28,116 |
| (2) Total from top of cross to church floor plinth ... ... ... ... | 51,214 |
| From church floor plinth to underside of foundations ... ... ... | 16,056 |
| (3) Total weight upon earth ascribable to the weight of the dome and its supports ... ... ... ... | 67,270 |

Of the total down to the floor plinth Mr. Drower estimates that 37,984 tons are carried by the eight piers and 13,230 tons by the four bastions. The load on the masonry at the foot of the piers is estimated at 15 tons per square foot, whilst that on the foundations below the piers is given as just over 5 tons per square foot.

Statements have been made to the effect that the stresses on the masonry at the springing of the arches is no less than 50 tons per square foot. With this estimate the committee disagree. They hold that a large proportion of the weight above this level is transmitted to the piers by the "internal arch" action of the masonry of the drum, below the great windows, which is 40 ft. in depth. This opinion is unquestionably well based and we may perhaps call attention, in this connection, to a series of highly instructive articles dealing with this very matter which were contributed to our columns in 1872 by the late Sir Benjamin Baker (see Engineering, vol. xiv, pages 1, 44, 73.) In these articles this eminent engineer directed attention to the absurdity of supposing that the arches spanning openings in high walls took more than a fraction of the total superincumbent weight, and he discussed in detail the question as to how much of the load might safely be considered as carried by this "internal arch" or beam action. In the case of the drum at St. Paul's the committee estimate that the real stress on the masonry at the springings of the arches is certainly not more than 25 tons per square foot. Tests made at the National Physical Laboratory of the strength of the Portland stone used show that this cracked at a stress of 400 tons per square foot and crushed at from 430 to 490 tons per square foot.

As for the piers, the committee report that, owing to the lack of good cements at the date of erection, the rubble interior has never properly consolidated. Lime mortars, in fact, will not harden unless they can get a supply of $CO_2$ from the air, and the masonry has been too thick to permit free access of the air.

The ashlar facing has suffered from the architect's craving for close joints. To ensure these the beds were relieved, with the result that there was a concentration of stress on the facing, which has spalled and flaked at the edges. A rebuilding of the piers is considered to be so dangerous as to be impracticable, and the committee recommend accordingly the grouting up of the rubble interior with cement much on the lines recommended some years since by Sir Francis Fox.

In some of the earlier experiments with this procedure the bore holes drilled in the piers were thoroughly washed out, and cemented with a very dilute grout. Subsequent examination showed that this had satisfactorily consolidated the interior, but that in the process damage had been done by dissolution of the plaster of paris in which some of the facing stones were set. It was accordingly decided to use a thicker grout. This was fed in at holes separated vertically by a height of 3 ft. and in many cases the grout forced in below, appeared at the upper holes, showing that the cavities were being well filled and the aggregate consolidated. This plan should, the committee advise, be proceeded with, but they recommend that, in addition, metal reinforcing bars shall be placed in the bore holes before the grouting is completed. If this plan be followed it is held that the piers will be rendered at least as sound as they were when first erected. The

following is the committee's summary of their recommendations, which are :—

(1) To consolidate the piers by grouting through bore holes on similar lines to the method adopted on the north-east transept pier already referred to, by strengthening the pier temporarily with steel and timber casing during the process, and by reinforcing the piers with metal rods embedded in the bore holes, to be followed by replacement of any defective ashlar.

(2) To encircle the drums of the dome with metal hooping to check any possible cumulative increase in circumference of this fabric.

(3) To repeat at, say, six-monthly intervals the series of levelling observations and also the plumbing and other measurements described in the report and for which special instruments have been provided.

(4) To guard against danger accruing from building operations in the immediate vicinity and below the level of the foundations of the cathedral.

## THE RATING OF MACHINERY AND PLANT.

THE report of the Inter-Departmental Committee on the Rating of Machinery and Plant in England and Scotland, which was issued a few days ago, will, if adopted by Parliament, put an end to a long-standing controversy. The committee seems to have been fairly representative of the various interests concerned, and its report, which is dated February 6, 1925, is addressed both to the Minister of Health and to the Secretary for Scotland. The committee's terms of reference, stated shortly, were to inquire into the present law and practice in regard to the rating of machinery and plant in England and Scotland, and to make recommendations as to what alterations, if any, were desirable and practicable with a view to the removal of inequalities and, if possible, the assimilation of the law and practice of the two countries.

In dealing with the existing state of the law in England, the committee start from the decision of the House of Lords in 1906 in Kirby *v.* Hunslet Union Assessment Committee, in which it was held that "tenants' machinery" placed in a factory and used for the business of the factory, whether affixed to the freehold or not, may be taken into account in the assessment of the factory for Poor Rate. Unfortunately, that decision contained no direction as to the way in which the machinery and plant should be "taken into account." Some overseers or assessment committees, after valuing the structure of the factory, have added only a comparatively small sum in respect of the machinery ; others have valued the machinery on the "Contractor's principle," in effect rating it as if it were actually part of the rateable freehold. Of late years there has been a tendency to adopt the latter method. As regards Scotland, the Lands Valuation (Scotland) Act, 1854, provided, in effect, that all machinery affixed or attached to any lands or heritages should be assessed as part of the lands and heritages. This was modified, later, by the Lands Valuation (Scotland) Amendment Act, 1902, which provided that in the case of any building occupied for trade, business, or manufacturing purposes all machinery or plant for producing or transmitting first motive power or for heating or lighting the building should be assessable, but that otherwise machines, tools, or appliances which were only so fixed that they could be removed from their place without the removal of any part of the building being necessitated, should not be assessable. Thus, in England all machinery, except loose tools, &c., must be taken into account ; whereas in Scotland in the case of buildings the only machinery to be assessed is machinery for first motive power, heating and lighting, and machinery so fixed that it cannot be removed without injury to the building. It is not surprising, therefore, that English machinery users have been agitating for over twenty years that they should have the benefit of the exemptions which are enjoyed by their Scottish competitors.

There are, however, differences between the systems operating in the two countries to be taken into consideration. In England all rates are paid upon a net value (*i.e.*, the gross value after deduction of the probable annual cost of repairs and insurance), whereas in Scotland all rates except Parish rates are paid on the gross value. Further, in England the contractor's basis is less rigidly applied than in Scotland. The committee have come to the conclusion, therefore, that, although theoretically it would appear desirable that the two countries should have similar systems of valuation and rating, they would not be justified in recommending the application of the Scottish system as to machinery and plant to England, or *vice versa*. The general law and practice as to rating are so different in the two countries that in the opinion of the committee any attempt at assimilation would upset the existing case law and would lead to confusion in one country or in both. Nevertheless, they are of opinion that machinery users in England are entitled to some relief, and their main recommendations are as follows :—

(1) The present practice of excluding from valuation loose tools, loose plant, and machines operated only by hand or foot power should be declared to be the law.

(2) Other machinery and plant should be treated as divided into two classes, as follows :—

CLASS I.—(i) Such machinery and plant (with the structures, works, erections and appliances supporting or holding them in place), including all engines, motors, shafting and counter-shafting, cables, wires, pipes, conduits, tanks, feed pumps, economisers, mechanical stokers, mechanical chargers and fuel conveyors, as are used or intended to be used mainly or exclusively for the purposes of or directly in connection with or ancillary to :—

(*a*) The creating, harnessing, conveying, controlling, applying, storing, transforming, converting or transmitting any form of power, whether steam, electric, water, gas, oil, compressed air, wind or other power (but not including portable or travelling power) :

Provided that no process or other plant or machinery to which any such power after full development up to the stage of application is applied shall be included in this definition :

(*b*) Lighting, heating, cooling, ventilating, draining, supplying water to or protecting from fire any part of the building or land of the rateable hereditament.

(ii) Lifts and elevators.

(iii) Railway and tramway lines and tracks.

(iv) Plant or a combination of plant and machinery which is or is of the nature of a building or structure ; such as gas holders, blast furnaces, coke ovens, tar distilling plants, cupolas, water towers with tanks.

CLASS II.—All plant and machinery now by law taken into account in estimating the annual value for assessment to poor rate, other than that which falls within the definition of Class I.

Class I machinery and plant should be valued as if it were actually part of the hereditament. Class II machinery and plant should, generally speaking, pay only 25 per cent. of the full rate.

(3) The value of Class I and Class II machinery and plant should be separately stated, and if called upon the assessor should give details of the valuation.

(4) Valuations should be made by professional valuers and at intervals of not more than five years, and a panel of referees should be set up for the purpose of deciding, subject to the opinion of the High Court, whether any piece of machinery falls within Class I or Class II.

As regards Scotland, the committee recommend that the distinction which arose under the Act of 1902 between machinery in a building and machinery not in a building should be abolished.

The report may occasion a certain amount of disappointment to English machinery users, but it is to be observed that it is signed by Sir James Remnant, M.P., who moved the second reading of the Rating of Machinery Bill of 1922, which was intended to exclude from rating in England all machinery which would be excluded in Scotland in terms of the Scottish Act of 1902. The committee's recommendations are therefore entitled to careful consideration by all parties concerned.

One of the members of the committee, Mr. Thomas White, the Chairman of the National Conference of Assessment Committees, dissents from the report and recommends that no alterations other than a few of an administrative nature should be made in the present law and practice in regard to rating of plant and machinery in England and Wales.

## THE INNER STRUCTURE OF ALLOYS.

ON Monday last, the 16th inst., Dr. Rosenhainf F.R.S., delivered at the Society of Arts the first of a series of three Cantor lectures, taking as his subject "The Inner Structure of Alloys." He stated that the structure of metals had formed the object of a very large number of papers read before technical societies, and dealing with various aspects of the question. The subject could be divided into the macro-examination and the more interesting micro-examination of structure. The inner, or atomic, structure of metals and alloys, developed of recent years only, was beyond these methods of examination and would provide the key to the numberless facts concerning metals which had been accumulated during the last forty or fifty years.

Dr. Rosenhain, by way of introduction, stated that the constitution of an alloy was expressed in the terms of an equilibrium diagram. It could be said that an alloy, or a group of alloys, was known when its constitution could be defined, and when there could be stated the proportion present in any alloy of any compound and how the compound existed at specified temperatures between absolute zero and the boiling point of the metal, and even beyond the latter point. As a rule, however, very low temperatures, and temperatures above the melting point, were not taken into account to any great extent, and the diagrams usually indicated the constitution between ordinary temperatures and the point at which the metals were completely liquid. Dr. Rosenhain exhibited on the screen a number of equilibrium diagrams of different alloys, starting with that of lead and tin, and ranging up to the more complicated ternary alloys, his object being to point out the information which it was possible to gather from such diagrams. A typical diagram shown, not applying to any particular system, revealed that if two metals, such as copper and nickel, were melted together, when solidification took place and equilibrium was reached by sufficiently slow cooling, a microstructure was obtained identical in most respects with that of a pure metal. The solid metal was built up of crystals that were alike, and the state of intimate mixture in the liquid state had been preserved in the solid crystals. These crystals could be seen under the microscope.

That the bodies seen were crystals was, he believed, first shown by the late Dr. Stead, and other scientists had since added to our knowledge of the subject. Dr. Rosenhain showed a slide depicting pure iron deeply etched, viewed under ordinary illumination. By vertical light on the surfaces various polygonal grains could be seen outlined by thin lines and differentiated from each other by various tints. When the specimen was illuminated by light falling obliquely, a different effect was obtained, an effect which bore to the first picture almost the same relation as that existing between a negative and a positive photographic plate. The reason for this was that the etching reagent used attacked the surfaces of the crystals to a certain extent, unbuilding them, and revealed their form by developing on the surface a series of facets. These facets were almost similarly directed in any one crystal, but the direction varied from crystal to crystal. When a vertical light was on a facet and the facet was almost horizontal, the greater part of the light was reflected back into the microscope. Those slightly inclined reflected a little of the light and appeared less bright. When the light was oblique the state of affairs was reversed ; the areas were dark which before appeared bright and *vice versa*. By rotating the light on the specimen the crystals flashed up in turn like little mirrors arranged at different angles. There were thousands of such mirrors in the specimen. Silicon steel revealed the phenomenon very beautifully, as was evidenced by

slides. One slide illustrated cadmium which had been allowed to solidify in contact with glass; there was on the glass a slight layer of gas or moisture which could not be expelled and the crystals built themselves around the particles of gas or moisture, leaving beautiful geometrical pits or holes, to accommodate the minute bubbles of the gas or moisture.

The intermetallic compounds were most puzzling. At first sight it would have been thought that two metals very much alike chemically could not form compounds at all, but they did do so, and that fact had to be reckoned with, the compounds being both very characteristic and very troublesome. Generally they were of very peculiar kinds, as they formed angular crystals nearly always hard and brittle. These little hard crystal types had a great deal to do with the usefulness of an alloy as a bearing metal. Interest in them was due to the fact that they were typical of the qualities of intermetallic compounds, differing from solid solutions, which latter were as a rule tough and ductile. Another example exhibited was an alloy of copper and aluminium, consisting of equal quantities of each, melted together and poured into a suitable mould. When crystallisation had proceeded to a certain extent beautiful needle-shaped crystals were formed; these were exceedingly brittle, which was astonishing, because copper and aluminium considered separately were two of the most ductile common metals. Yet the inter-metallic compound formed was, as seen, entirely different, and was characteristic of the chemical combination which had taken place.

Physicists had now developed a method—as Dr. Rosenhain mentioned in his opening remarks—of studying atomic structures by X-rays, a method which had already had most interesting and far-reaching results. It was first discovered by von Laue that crystals could diffract X-rays. It had long been known that if a light wave fell on a series of obstacles placed at a distance apart of the same order as the length of the light waves themselves, the well-known diffraction spectrum was obtained. What happened was this. Each of the obstacles acted as the source of a new light wave. The light was scattered, if one liked, by each of these obstacles, and if it so happened that the light from the successive obstacles reached a screen or the eye in such a manner that the waves sent out from one obstacle reinforced and coincided with the waves sent out from the next, and so on, there was a very bright reflection at particular points. But if the crest of the wave sent out by one obstacle coincided with the trough of the wave sent out by the next, they extinguished each other, producing darkness. The alternations of light and darkness in the reflected beam depended upon the spacing of the obstacles and upon the length of the waves of light used. If one factor were known, by measuring the spacing of shadows and light on the screen, the other could be determined. If the wave-length of light falling upon a grating was known, by measuring the distance apart of the light and dark bands, one could calculate the distance apart of the lines of the grating; or, knowing the distance apart in the lines of the grating, one could calculate the wave-length of light falling on it. The wave-length of the X-rays was from 1,000 to 50,000 times smaller than the wave-length of the shortest wave of visible light. One could not rule a grating sufficiently fine to get an X-ray spectrum. One could, perhaps, rule 200,000 lines to the inch, but not 20 million; if we could, our materials would not be fine enough to stand such rulings. But nature had arranged in crystals atoms and molecules, grouped at distances apart, which were just about right to produce the diffraction effect with the wave-length of X-rays.

There was for a long time a controversy as to what X-rays were—pulsations or corpuscles. Ultimately the idea predominated that they must be waves, and the idea of waves once accepted, the next step was to find some means of analysing those waves. Von Laue hit upon the idea that the spacing of atoms and molecules in a crystal, where, presumably, the arrangement would be regular, would be just the thing. He carried out calculations and showed mathematically what would happen, and thus opened up a new path for the investigation of the inner structure of matter.

What happened with X-rays passing through a crystal or reflected from it corresponded exactly to the production of a diffraction spectrum by a grating. The various layers of atoms acted as successive reflectors, and according as those layers of atoms were certain distances apart, according as these were such as to make the reflections reinforce each other crest to crest, or blot each other out crest to trough, so one had light or darkness, *i.e.*, X-ray light or darkness, upon the screen. One could determine the existence of a reflection or darkness by various means, by a photo-film, or by using an ionisation chamber—the X-rays producing certain effects when emitted in a chamber containing certain gases. That method had been much developed since the days of von Laue; his method had great limitations and the developments since made were due to Sir W. H. Bragg and to Mr. W. L. Bragg in this country, to Debye and Scherrer on the Continent, also to Mr. A. W. Hull, and had provided a most powerful means for crystal analysis. The result was such that not only were the wave-lengths of X-rays known, but also the exact distance apart of the atoms in a great many crystalline substances. When he said exact, Dr. Rosenhain thought it right to add that in many instances the distances were known, minute as they were, to an accuracy of much less than one-half of one per cent. These distances were of the nature of 2 to 5 angstrom units, and one angstrom unit was 1/10,000,000th of a millimetre. Measurements to the degree of accuracy now possible seemed almost unthinkable.

As a result of this development by physicists, made without thought of the metallurgist, facts of great importance had been brought out concerning metals.

That metals were crystalline was known before, since metallurgists had discovered that fact over 20 years ago. The X-rays told more than that mere fact; they showed not only that there were crystals in the metals, but also the kinds of crystals and the exact way in which the atoms were arranged in the crystals; the method of their arrangement was peculiar and interesting. The atoms were arranged in a network usually termed a space-lattice. Here Dr. Rosenhain exhibited on the screen diagrams and showed built-up models illustrating a face-centred cubic lattice; the atoms were represented by balls; other diagrams and models illustrated a body-centred cubic lattice; this having an atom on the centre of the body of the cube. (Similar diagrams can be found in former articles in Engineering, notably in our issue of June 17, 1921, page 757.) He explained that if one took spherical balls of any kind and packed them together as closely as possible, the face-centred lattice was the outcome. They could be packed for the body-centred lattice but would occupy a larger space. Therefore the face-centred lattice was close packed and the body-centred not close packed. A model of an hexagonal lattice was also shown. Zinc and cadmium followed the hexagonal system of crystallisation, and copper, aluminium, gold and silver the cubic system; this difference represented different properties. But there were other metals which were "less well behaved," which crystallised in yet a different way, the space was not divided into a perfectly symmetrical system of cells, cubic or hexagonal, the cube being slightly distorted into a rhomboid. Here, also, there were two sets of lattices, as represented by models, illustrating, for example, antimony and bismuth, which were brittle, and had lattices differing from the regular cubic and hexagonal system. Dr. Rosenhain showed, further, a table of constants for a very large number of the more important metals, the distances quoted being those from centre to centre of the points round which the atoms swing, and varying from under 3 to 6·5 angstrom units.

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Ship Regulations.—The Board of Trade has issued two circulars containing instructions to surveyors of ships. The first deals with coal-carrying vessels and deals with coamings, loading, and the security of hatchways, while the second contains rules on wireless telegraphy installations and searchlights for ships' lifeboats.

## THE BRITISH INDUSTRIES FAIR AT BIRMINGHAM.

The British Industries Fair organised in conjunction with the Birmingham Chamber of Commerce is again being held in the Exhibition Buildings at Castle Bromwich. Last year it took place in May, but by opening it on Monday last, the authorities have returned to the period in which it has been customary to hold it in previous years. The exhibition is somewhat exceptional in that the general public are excluded, admission being confined to representatives of business houses. There can be no doubt but that, in thus excluding mere sightseers, business is greatly facilitated, and the example which is set by this exhibition in this respect might be copied with advantage by other authorities. The primary object of the exhibition is to advertise the goods manufactured in Birmingham and its neighbourhood as widely as possible, and that the enterprise of the Chamber of Commerce in making this effort is duly appreciated is shown by the large number of foreign visitors who throng the exhibition buildings. The exhibition undoubtedly suffered to some extent last year owing to the counter attraction of the British Empire Exhibition at Wembley, but the action of the promoters in returning to the original date of opening should do much to minimise any similar effect in the present instance. In view of the continuance of the Wembley Exhibition this year, the Department of Overseas Trade have decided not to hold the London section of the British Industries Fair this year, and, as a result of this decision, arrangements have been made with the Birmingham Chamber of Commerce to provide space in their fair buildings for exhibitors who normally would have been entitled to show under the London classification. As might be anticipated from a study of the industries located in the Birmingham area, a large part of the exhibition is given up to a display of those articles which are known colloquially throughout the world as "Birmingham Goods," and these hardly come within our scope, but, in addition, a number of more purely engineering exhibits can be seen on the stands of the various engineering manufacturing firms. This year there is a distinct falling off in the number of machine tool exhibits, never a strong section on account of the action taken by the Machine Tool Trades Association in prohibiting their members taking part in the fair, but there is a distinct increase in the number of firms exhibiting moderate-powered internal-combustion engines of the stationary type, and, in fact, in this particular section most of the well-known firms are represented.

Messrs. Blackstone and Co., Limited, of Stamford, are exhibiting a 55-brake horse-power single-cylinder Blackstone oil engine of the horizontal type. This engine is cold-starting and burns low-grade fuel. It is a new model and has a guaranteed consumption not exceeding 0·4 lb. fuel per brake horse-power hour. The fuel is injected by means of a spring plunger, composed of two members separated by a spiral spring. A governed pump delivers fuel to one end of this plunger, and the fuel moves the whole of the plunger with its spring bodily outwards, so that the pump does not have to work against pressure. The spring of the plunger is then compressed by a lever which presses upon its outer member, the inner one being held by abutting upon the fuel, which is retained by the spraying valve. At the inward end of its travel the lever relieves the pressure of a second or auxiliary spring—which normally keeps the fuel-spraying valve closed against the injection pressure—allowing the pressure of the fuel to open the valve when the spring of the plunger expands, forcing the fuel past the valve into the combustion chamber, where it is ignited by the heat of the compressed air. By this arrangement the fuel is injected under the same pressure whatever the speed of the engine, and this enables the engine to be started from cold with the fuel on which it is to continue running. The compression pressure is 350 lb. per square inch, and the initial pressure on full load 550 lb. per square inch; the mean effective pressure being 100 lb. per square inch. The same firm exhibit a 7·5 brake horse-power single-cylinder horizontal oil engine, direct coupled to a dynamo for country-house lighting, and also one of their unchokeable pumps.

# EXHIBITS AT THE BRITISH INDUSTRIES FAIR.

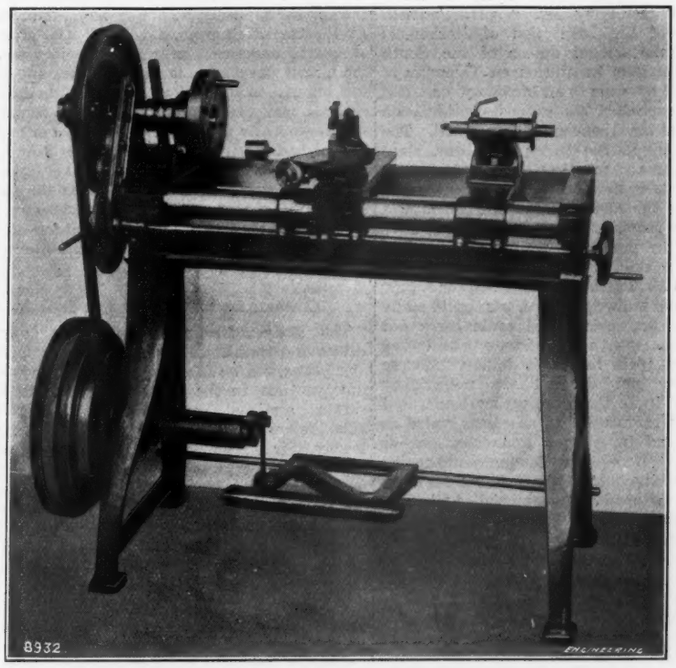


FIG. 1. 4½-IN. CENTRE FOOT LATHE; THE EXE ENGINEERING CO., LIMITED.

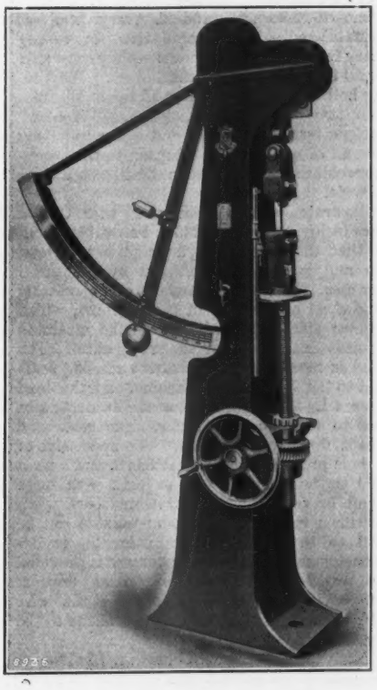

FIG. 2. WIRE TESTING MACHINE; MESSRS. W. AND T. AVERY, LIMITED.

In our account of the Fair held last year we gave a description of an amateur's lathe with 2½-in. centres, made by the Exe Engineering Company, Limited, of Exeter. We illustrated and gave further details of this lathe in our issue of January 23 last. The firm are again exhibiting this lathe, and in addition their small foot-operated capstan, which we dealt with on January 23, and a 4½-in. centre foot-operated lathe of new design. This lathe is specially intended to meet the requirements as regards general machine work in small garages, where a power plant with large machines could not be justified, but we imagine that it will make a strong appeal to amateurs who require a machine capable of handling larger diameter work than can be done in the usual small machine of this type. The machine is illustrated in Fig. 1 from which it will be seen that the bed consists of two members spaced a considerable distance apart, the front member being circular and the rear member rectangular. The arrangement gives the equivalent of a gap bed for the whole length of the machine, and actually, although the centre height is only 4½ in. nominally the lathe will swing 14 in. anywhere except over the saddle. This feature should prove of great value in general garage repair work. Another advantageous feature from this point of view is the provision of a large hollow mandrel in the headstock. It is possible to pass a 1⅝-in. diameter bar right through, and it would therefore be possible to deal with such a part as the end of a cardan shaft by holding it in the chuck. It is customary for foot-operated machines which are intended to handle work of anything over a small diameter to be fitted with a treble reduction back gear, but the manufacturers of this lathe have dealt with the problem of getting a sufficiently low speed for work up to the capacity of the machine by the provision of special steps on the belt cones. In the illustration the belt is seen on these cones. Back gears are thus entirely eliminated, and we were shown a sample of a cast-iron flange about 8 in. diameter with an excellent finish which had been turned on this machine.

Another very interesting feature of the lathe is the provision of a dog clutch on the mandrel which overcomes all difficulty in picking up the thread when screw cutting to a pitch which is not a simple multiple of that of the leading screw. With this clutch no difficulty is experienced whatever may be the pitch. When the tool reaches the end of the thread it is withdrawn in the usual way. The clutch is then opened and the saddle screwed back, and closing the clutch again automatically registers the tool in the correct position. The tailstock can be set over for cutting taper in the usual way, and for dealing with tapers when the work is held in the chuck or on the faceplate, provision is made for a swivel action by slacking off the two front holding-down bolts. It will be noticed that the change wheels are in a very handy position, and that the leading screw can be thrown out of action by a second clutch, the handle for operating which is seen projecting beyond the belt at the left-hand end of the machine. A ball-bearing treadle is provided and the machine generally appears very substantial and capable of withstanding a certain amount of rough usage. It appeared to us that the flywheel might be increased in weight somewhat with advantage, but there is no doubt that the machine is excellent value, the price being approximately 24*l*. Practically no change has been made in the smaller machine which we described last year, but the small capstan lathe to which we have already referred has been improved in detail. A new collet chuck has been fitted which enables work up to ½-in. diameter to be locked without the aid of a key. The operation is performed by means of a large flange milled on the outside, the centre portion being held by gripping the belt pulley. Another feature which has resulted in an improvement is the provision of a spring behind the collet jaws, which causes them to release the work as soon as the flanged nut is slacked off.

Messrs. R. C. Gibbins and Company, of Birmingham, are exhibiting a variety of lifting appliances, amongst which a 10-cwt. portable garage crane was noticeable for its clean and simple design. Curved girders have been entirely eliminated from the framework and their place has been taken by a triangulated structure built up almost entirely with angle bar. The purchase is obtained by means of a single worm and wheel. The two rear wheels are on ball-bearing castors, so that the crane can be readily wheeled about the workshops. The price is 15*l*. Another exhibit of the same firm was a new design of quick-lift builders' friction hoist. This machine is capable of lifting a weight of 5 cwt. at the rate of 150 ft. per minute. It is quite self-contained and of simple and robust construction. The braking action is obtained by bringing a large flange on the winding drum in contact with the Ferodo-faced brake block. The swinging action of the drum spindle is obtained by mounting the end carrying the lever in an eccentric, sufficient play being left in the bearing at the other end to allow the very small amount of movement necessary, to take place. The arrangement might be considered somewhat un-mechanical, but would probably be entirely satisfactory in the class of work for which the mechanism is intended. The same firm are exhibiting an 8-ton direct-lifting wire rope winch and a variety of jacks, amongst which may be mentioned the "Earlstown" wagon-lifting jack, which is exceptional in being fitted with a ball-bearing head which is claimed to give a very considerable increase in efficiency.

Messrs. Crossley Brothers, Limited, of Manchester, are exhibiting a 12 brake horse-power Crossley single cylinder town-gas engine, which is fitted with variable admission governing, a somewhat unusual feature on so small an engine. An excellent feature of this engine is that both the cam and governor shafts are self-aligning, ensuring that they could be taken down and reassembled by comparatively unskilled labour if required. The governing arrangement follows the lines of their larger engines, which are sufficiently well known to make a detail description unnecessary. The engine is magneto ignited and can be supplied to run on any of the usual light liquid fuels in addition to town-gas. Messrs. Crossley are also exhibiting one of their 31 brake horse-power horizontal cold starting oil engines, and also their 14 brake horse-power vertical two-stroke enclosed type crude oil engine. The latter was first shown on their stand at Wembley last year. It is fitted with a separate scavenging pump attached to the side of the engine frame. The fuel pump is operated from the crankshaft by means of a cam and lever, and the fuel is injected through a sprayer into the combustion chamber. The engine

can be run on paraffin or any of the usual oils suitable for Diesel type engines, and it is claimed that the 14 brake horse-power engine only consumes ½ pint of fuel per brake horse-power-hour.

The firm of Messrs. W. and T. Avery, Limited, have established a high reputation for testing machinery in addition to the position they have long held for all types of weighing machinery. They are showing both classes of machine at the exhibition, and show two wire-testing machines, a "Wohler" type fatigue testing machine, and a spring-testing machine, all of new type, in addition to their well-known machines for compression, tensile, shear and torsion tests.

We illustrate one of their new wire testing machines in Fig. 2, on page 235. From this it will be seen that the specimen is inserted in a vertical position and is held at each end by the usual gripping dies. The load is then put on by rotating the handwheel on the left of the machine, which draws down the lower dies through the straining screw which is acted on by the wormwheel. The extension is measured on the direct reading scale attached to the front of the machine, and the load is measured by the angle of tilt of the swinging arm attached to the top wire holder. The graduated scale reads directly in pounds. The upper side of this scale is provided with rachet teeth, and a pawl attached to the swinging arm engages with these teeth and prevents the arm swinging back when the specimen breaks. Additional weights can be attached to the end of the arm for larger diameter specimens. A quick-action device is provided on the nut for obtaining the initial tension. Special provision is made for opening the wire grips by a cam action to enable specimens to be quickly fixed.

The National Gas Engine Company, Limited, of Ashton-under-Lyne exhibit one of their 66 brake horse-power National crude oil engines, self-starting from cold; a 15 brake horse-power National town-gas engine with magneto ignition and hit and miss governing; and a "K.E." chain driven lighting set, to work with gas or light liquid fuels. The latter machine has been on the market about eighteen months and consists of a single cylinder horizontal engine with two flywheels driving a 3 kw. dynamo through the medium of a silent chain, totally enclosed and running in oil. The engine at the exhibition was arranged to run on paraffin, the carburettor being of the ordinary jet type with a hot air supply from an exhaust pipe muff. A two-way cock on the fuel supply pipe allowed the engine to be started up on petrol, and the change over was quite imperceptible in the exhaust of the engine. Ignition is by means of an oscillating type magneto, the trip mechanism being operated by an eccentric on the camshaft, and the governor was coupled up to a butterfly throttle valve in the induction pipe. The combination is intended to be run in conjunction with batteries, but at the time of our visit was being used to light the company's stand directly from the dynamo, and under these conditions there was no perceptible flicker on the lights.

Messrs. Howden-Ljungström Preheaters (Land), Limited, of 133, Helen-street, Govan, Glasgow, exhibited a pre-heater of the type which was shown at the Wembley Exhibition. This consists essentially of a vertical circular casing, in the centre of which a rotor is fitted resting on four wheels. The rotor is made up of a frame carrying a large number of vertical corrugated sheets, which are mounted radially in the frame and constitute the elements by means of which the heat is transferred from the flue gases to the furnace air supply of the boiler.

The frame carrying the elements is slowly rotated, and the latter alternately pass through the uptake carrying the hot gases and the downtake passing the cold air to the furnace. Circulation of flue gas and air is maintained by means of two fans mounted above the rotor and keyed to a common spindle. The whole apparatus is self-contained and may be mounted in any convenient position relative to the boiler. It is claimed that the pre-heater picks up from 60 per cent. to 70 per cent. of the available heat of the flue gases, and that an increase in the boiler efficiency of about 17 per cent. results from its use.

*(To be continued.)*

## NOTES.

### The Supply of Mechanics.

The question of the future supply of skilled mechanics was raised by Mr. W. H. Patchell, the President of the Institution of Mechanical Engineers, at the annual dinner of the South Wales branch of that Institution on Thursday of last week. The question is an important one, and Mr. Patchell suggested its serious consideration by the leaders of the labour unions concerned. The matter is largely in the hands of labour, since union regulations and practices have so specialised functions that it is now extremely difficult for a boy to receive the all-round training which was usual in earlier years. Modern developments have produced, and are producing, men of very remarkable specialised skill, as, for instance, in gauge making, but as Mr. Patchell pointed out, the supply of men of the old millwright type, who could really use a hammer and chisel, and could carry out most repair jobs with a kit of tools which they could carry in their hands, is failing. Modern conditions may not demand the millwrights' all-round skill from the average mechanic, but such skill will always be of enormous value in repair work, and in erection and other outside work generally. If organised labour would realise that their restrictive methods are pulling down the skilled men to the level of the semi-skilled labourer, it might do something to help toward ending a vicious system. A race of properly-trained all-round mechanics who could and would operate a lathe, scrape and face valves and erect an engine, would without difficulty take a position both in status and wage well in front of the promoted labourer with whom, under present ideas, the skilled man appears to wish to identify himself. This subject forms one of the main items of Mr. Legros' presidential address which is dealt with elsewhere in this issue.

### The Properties and Structure of Quartz.

In the third lecture of his course on the above subject delivered at the Royal Institution on Thursday, February 12, Sir. W. H. Bragg said that a first application of X-rays methods of crystal analysis had shown that the unit of pattern, by the repetition of which a crystal of quartz was built up, consisted of three molecules of $SiO_2$, which were arranged in a helix, the axis of which was parallel to the principal axis of the crystal. This investigation had been made about 10 years ago, and subsequent work had shown that this screw structure was sufficient to account for the fact that quartz had the property of rotating the plane of polarisation of light. Other crystals possessed the same property for the same reason, and bodies like sugar could rotate the plane of polarisation even when dissolved, the reason being that a right-handed screw always remained right-handed, even when turned end for end. In the sugar solution the screws pointed in every direction, but those which were transverse to the path of the light had no effect, whilst the others all produced rotation in the same direction. Whilst the first X-ray studies had given the unit of pattern in the quartz structure, they still left undetermined the arrangement of the atoms in the molecules of $SiO_2$. As to this, some conclusions could be drawn from a study of the intensities of the lines in the X-ray spectrograms. The reflection of X-rays by the atoms of a crystal was analogous to the production of a spectrum of ordinary light by a grating. Such a grating produced not merely one spectrum, but an indefinite number of different orders of spectra, and the intensity of different orders was affected by the character of the ruling. If we made the groove very heavy, some of the spectra would go out, whilst other orders would be strengthened. If, again, we ruled two lines and missed one, and repeated this sequence for the whole grating, then the second, sixth and tenth orders would disappear, or if we put a fine line between two heavy ones the even orders came out. A corresponding phenomenon occurred with X-rays, and the problem was to determine from measurements of the intensity of the lines the relative positions of the heavy silicon atoms and of the lighter atoms of oxygen. The problem was a very difficult one, but the work had to some extent been facilitated by the fact that if the temperature of a quartz crystal was raised to about 573 deg. C. or 575 deg. C., a certain re-arrangement took place, the crystal suddenly becoming more symmetrical. At the transition point almost all the properties of quartz underwent a sudden modification, but the former structure was restored when the crystal was allowed to cool. Nevertheless, although these changes took place as stated, the two forms were still very closely allied, but whilst the $\alpha$ or ordinary crystal had a trigonal symmetry, the $\beta$ or heated crystal was hexagonal. By a careful study of this latter form it had been possible to fix the position of the oxygen atoms. The final conclusion arrived at was, that in quartz the oxygen atoms occupied the corners of a tetrahedron of which a silicon atom formed the centre.

### Research in the Electrical Industry.

The British Electrical and Allied Industries Research Association has now been in existence some four years, and we have had occasion to refer from time to time to the valuable work done by its various sectional committees. Speaking at a lunch following the annual general meeting last Friday, Sir Frank Heath pointed out that the electrical industry was in a position entirely different from others, such as leather and linen, on account of its comparative youth; and that as a consequence each step forward had been a direct result of research work rather than of the trial-and-error methods which had commonly governed progress in the past history of the older industries. It is less than a hundred years since Faraday laid the foundations of the industry by his classic experiments, and since that date it has been extraordinarily fortunate in its scientific workers, as is sufficiently made evident by mention of such names as Clerk Maxwell, Thompson, Lodge, Hopkinson, and Ferranti. Sir Frank Heath made a comparison between American and British methods of research, and in this connection mentioned the striking fact that an association of three electrical companies in America spent more on research annually than all the other industries put together. In speaking of the past work of the Association at the same lunch, Sir Phillip Nash said that he thought that their outstanding work was in connection with improvements in insulating materials, which formed a typical example of the advantages of the methods adopted by the Association in bringing together workers in widely different fields, who might, nevertheless, have a close common interest. Although insulating materials formed one of the most essential items in all classes of electrical work, their manufacture was quite outside the scope of the industry, and on this account the development of new and more efficient insulating materials must of necessity be slow, without the close collaboration between the two interests concerned in the working of the Association.

### Cold Drawn Iron and Steel.

The cold drawing of mild steel containing carbon 0·115, silicon 0·048, phosphorus 0·051, sulphur 0·037, and manganese 0·530 per cent., formed the subject of a paper read by Mr. R. M. Brown, on the 10th inst., before the Institution of Engineers and Shipbuilders in Scotland. The tests, which he described at great length, were made to ascertain certain effects of cold drawing; the scope of the first experiments was reduced to the narrowest possible limits. The simplest case being that of single-stage reduction, a series of experiments was made to investigate the effects and limitations of a single pass. Bars of steel of the above analysis of different diameters were cold drawn to a final diameter of 0·45 in.; the speed of drawing was maintained as nearly constant as possible, using a series of bars whose original diameter increased progressively by thirty-seconds of an inch in order to vary the amount of cold work. The smallest bar had a diameter of 0·4704 in. and the largest a diameter of 0·6861 in. The percentage reduction of area was respectively 8·7 and 57·45. It was found, in the conditions of the experiment, that the possible limit of reduction of area could not greatly

exceed this latter value, but would probably be increased by taking special precautions in cleaning and by providing a very efficient system of lubrication. The experiments showed that there were considerable variations in the properties of cold drawn steel due to ageing, as evidenced by tests made at varying periods after drawing. Acting in the belief that the chemical composition might perhaps have a great influence upon the differences found, Armco iron bars were dealt with also, but the results with them proved surprisingly variable. Experiments were also made using steel conforming to the Air Ministry Specification S. 1, and comparative test figures included this grade of steel. The author entered in great detail into all the physical tests he carried out with the metals in the cold drawn state at different phases and periods of his experiments, and in doing so he confirmed the emphasis, which, in his opening statements, he laid upon the absolute necessity, when giving the test figures of cold drawn steel, of adding to these the particulars of the treatment such steel had received. It is to be noted that the author's interesting investigation is being continued and its scope gradually enlarged.

## THE CORROSION OF METALS.

Two papers on the corrosion of metals and its prevention were read before the Faraday Society on the 16th inst. Dr. W. M. Thornton and Mr. J. A. Harle, M.Sc., of Armstrong College, dealt with "The Electrolytic Corrosion of Ferrous Metals" and its study by "forced electrolytic corrosion," the metal or alloy being made the anode in diluted sulphuric acid. The 44 specimens tested had been prepared by Sir Robert Hadfield so as to render the results comparable with the acid tests of the Institution of Civil Engineers. The loss of weight of the specimen was determined after various intervals, ranging from six hours up to 92 hours. Although the specimens were used as submitted, Dr. Thornton did not observe any skin effect; the corrosion curves were straight lines from the beginning and did not show any bend at the start, except in the case of the cast Galahad steels. These specimens were full of blowholes invisible on the surface; the corrosion was slow at first, but as soon as the surface was broken the blowholes became visible and the rate of corrosion increased, the metal being apparently more corrodible at the edges of the cavities. Era and Hecla steels and mild steels containing copper were found to corrode more easily than pure iron, even when divalent, Swedish charcoal iron and Armco iron; the high nickel steels and worked Galahad steels corroded least. Dr. Thornton regarded the corrosion as an oxidation effect and suggested that the rate of corrosion was characteristic of every ferrous alloy, so much so, indeed, that an alloy might be identified and classified by its rate of corrosion under certain conditions. The question is whether these forced tests in acids, which have the advantage of uniform conditions, and consequently of comparability, afford much guidance to the behaviour of the metals under the conditions of ordinary atmospheric exposure. This is the really interesting point. Dr. Thornton's classification is not in accord with others, as was pointed out by Mr. W. H. J. Vernon, whose report to the Atmospheric Corrosion Research Committee of the British Non-Ferrous Research Association was presented to the Faraday Society a year ago. Different tests, indeed, lead to different groupings.

The second paper by Professor Cecil H. Desch, F.R.S., and Mrs. E. M. Vehan, on "The Electrolytic Deposition of Cadmium and other Metals on Aluminium," dealt with the protection of aluminium and its alloys, and referred to tests made at Sheffield both on small square plates and on large objects. Dr. Desch admitted that other methods of protecting aluminium against atmospheric corrosion were on the whole more successful than electro-plating. But he had obtained very good results with cadmium plating, 0·001 in. thick, even on aluminium tubes, which could be bent double or flattened out. In cleaning the specimens to be treated Dr. Desch pointed out that alkaline solution should be avoided, because commercial aluminium was porous and the alkali entered the pores. Sandblasting, followed by coppering for a minute or less (dipping into a cyanide bath), drying and again sandblasting, seemed to be the best preparation. Dr. Desch recommended a sulphate bath, containing 100 grams each of cadmium sulphate and potassium alum per litre, and a current density from 15 amperes to 30 amperes per square foot; some ammonia and peptone were added to the bath. Thin cadmium deposits, which were of pleasing colour and appearance, protected aluminium much better, even in the severe salt-spray tests, than did coatings of nickel, copper, or zinc. Cadmium deposits also prevented the rusting of steel.

# LETTERS TO THE EDITOR.

## ANTI-FRICTION BEARING APPLICATIONS FOR HEAVY DUTY.

TO THE EDITOR OF ENGINEERING.

SIR,—In your issue of February 13, in the discussion on Mr. Dahlerus' paper on "Anti-Friction Bearing Applications for Heavy Duty," Mr. D. B. Spittle is reported as having made a statement to the effect that the attempt to reduce the friction of the necks of cold rolls by the use of Michell bearings had been unsuccessful.

So far as we are aware, only one mill has been so fitted, an account of which was given in your issue of December 5 last, as a supplement to your series of articles on this difficult problem.

This application of the Michell principle is admittedly still in the experimental stage, but the fact that true pressure oil film lubrication in such bearings is a practical proposition has been demonstrated.

From the numerous inquiries we have received to convert existing mills fitted with roller bearings to our system, it would appear that such use of these bearings also leaves something to be desired.

Yours faithfully,
For MICHELL BEARINGS, LIMITED,
H. T. NEWBIGIN, Technical Director.

South Benwell, Newcastle-on-Tyne.
February 16, 1925.

## THE PREVENTION OF CORROSION.

TO THE EDITOR OF ENGINEERING.

SIR,—On February 3, Mr. S. F. Barclay, Ph.D., delivered a lecture on "Corrosion, and its Prevention," to the Manchester Metallurgical Society. During the course of the lecture, Mr. Barclay pointed out that, although the theories put forward to account for corrosion appeared to vary, they were virtually nothing more than other aspects of either the colloidal or the electrolytic theory. In summing up, the lecturer pointed out that stainless steel and silicon iron would go far in solving the corrosion problem. It is, however, evident that stainless steel is, and is likely to continue to be, far too costly for general purposes, such as steel structures, boilers, &c.; silicon iron presents considerable difficulties if any machining is required to be done upon it; moreover, there are vast quantities of ferrous materials at present in use, and so, even if the price of stainless steel is reduced so as to compare favourably with the cost of the older product, many years must elapse before the new can replace the old.

Before putting forward some further ideas on the subject, I should like to say that the various methods, at present in use for reducing the extent of corrosion, may be divided roughly into three main groups, viz.:

(*a*) The coating of the metal with a comparatively incorrodible surface, *e.g.*, galvanising, passifying, painting, &c.

(*b*) The introduction of some more electro-positive element, which has a neutralising effect on the charges that might otherwise cause corrosion of the surface it is desirable to protect, *e.g.*, zinc plates, in boilers, &c.

(*c*) The purification of the mobile medium coming into contact with the metallic surface, *e.g.*, the degasification of boiler feed water, &c.

The electrolytic theory of corrosion is generally accepted as the one which most successfully explains the observed facts. Now the hydrogen ion is a factor common to all cases of corrosion. I suggest that, for a specimen under a given set of conditions, the rate of corrosion is proportional to the hydrogen ion concentration, *i.e.*, the $P_H$ of the solution surrounding the metallic surface: that is to say, the higher the hydrogen ion concentration, the greater the corrosion. Therefore, it would appear that, if suitable substances could be found, which, coming into contact with the metallic surfaces as intimately as the medium carrying the hydrogen ions, would "buffer" or "regulate" the hydrogen ions in such a way as to cause the hydrogen to become de-ionised, corrosion could be controlled.

It has been found that the addition of proteins, amino-acids, and certain salts, such as the soluble phosphates, carbonates, and borates, lowers the $P_H$ of media used for the preparation of bacteriological cultures, and, for the same reason, the introduction of certain colloids into the electrolyte is advantageous in producing a good metallic deposit on the materials to be plated. The varnishing of condenser tubes has been found to retard corrosion considerably, both because the varnish acts as a protective coating, and because it contains "regulating" constituents, which lower the hydrogen ion concentration of the water. Iron, when newly embedded in concrete, is attacked by it, but the products formed resist further corrosion, possibly owing to the formation of some salts of iron, which lower the $P_H$ in their immediate vicinity, so that the concrete ultimately protects the iron, because the surface of the metal is not readily disturbed.

I maintain that, especially in steam plants, the addition to the mobile material of such "regulators" as I have herein indicated, will prove of immense value to the engineer until such time as incorrodible materials are readily available, under conditions which will compare favourably with the mild steel and cast iron of the present day.

Yours truly,
J. VERNON SHAW.

Warrington, February 14, 1925.

## THE DETERMINATION OF STRESSES BY OPTICAL METHODS.

TO THE EDITOR OF ENGINEERING.

SIR,—I am glad to note in Professor Jasper's letter, published in your issue of January 30, that he now admits what he formerly denied, that the maximum stress at a hole in an isotropic elastic tension member of great width is three times the mean value.

The only other point of his remarks at Toronto which I ventured to doubt five months ago was his statement that we are on the eve of a method which will not depend at all on optical principles. It now appears from his letter that we have still to wait about six months for its publication. On this second point, therefore, Professor Jasper has so far failed to substantiate his prophecy. If and when this paper appears it will receive the careful scrutiny such a communication would require.

In this last letter Professor Jasper says that his remarks at Toronto were directed to a paper of mine, which, in my absence, was read for me, and which in its presentation dealt in part with stresses and methods of analysis in gearing under dynamical forces using optical methods. Although this is the categorical statement of a witness presumably present, I can only say that so far I have never yet written or produced anything dealing with dynamical stresses in gearing or in anything else. I can therefore say with confidence that no paper of mine on this subject was read at Toronto.

Yours faithfully,
E. G. COKER.

University of London, University College,
Gower-street, London, W.C.1.
February 16, 1925.

## BRITISH MACHINE TOOLS AT EXHIBITIONS.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to your correspondent's letter on the above subject appearing in your issue of the 13th inst., the writer appears to have overlooked the fact that Olympia was booked for the Machine Tool Exhibition of last year before the date of the British Empire Exhibition was changed from 1923 to 1924. The Association, I believe, could not have withdrawn from this arrangement except at great expense. At the same time, the absence of machine tools from the Empire Exhibition was most certainly to be deplored, and the policy of the Machine Tool Trades Association might with advantage be made a little more flexible to meet such cases. At present I believe the idea is that on the understanding that members of the Association do not exhibit between whiles, that body undertakes to hold an exhibition every three years. Might not greater freedom be secured by an arrangement allowing members to exhibit where and when they liked, provided they supported the Association's own show held at three-yearly intervals? There are, perhaps, objections to this, but the present line of action does not seem to be an altogether happy one.

With regard to expense, it is to be noted that the cotton industry thought it worth while to run a working exhibit throughout the season at Wembley. Though a machine-tool exhibit of a corresponding class might have been more difficult to arrange, it would have proved no less attractive, while, in the opinion of numbers of Indian and Dominion visitors, even a representative display of idle running or motionless tools would have been of immense value, since leave in many cases did not extend into the fall, to the time of the Machine Tool Exhibition itself.

Yours faithfully,
M.I.MECH.E.

London, February 16, 1925.

## DUTCH SHIPBUILDING AND REPAIRING.

(From a Correspondent.)

Dutch firms have recently captured so many orders for ships, and have done so much repair work, whilst we have been suffering severe unemployment, that a consideration of the conditions under which they are able to secure and carry out such work is of interest. Last year the Dutch launched shipping aggregating 217,500 tons, plus 2,000 tons launched in their colonies. Most of the vessels built were river craft, but among sea-going ships of 1,000 tons or more put in the water in 1924 were the following:—Nedderlandsche Sheepsbouw, Amsterdam; t.s. motor, 9,500 tons; and two tankers of about 2,700 tons. C. van der Giessen and Sons, Krimpen, a.d., Ysel, s.s. cargo, 3,615 tons. P. Smit, jnr., Rotterdam, coaling steamer, 1,600 tons. Rotterdam Dry Dock Company, motor tanker, 4,647 tons, and three tank steamers of about 2,700 tons. New Waterway Company, Scheidam*, two cargo boats of 2,177, one of 4,400, and two of 1,450 tons, &c.

The Dutch built 102 ships, tugs, lighters, barges, &c., for British owners, and they did many hundreds of thousands of pounds worth of repairs for our people last year. Not only so, but they obtained such work, both building and repairing, from foreigners formerly regarded as our regular customers. To-day one Dutch yard has a 32,000*l.* alteration job on hand to a British order, and there are eight big British vessels under repair at three Rotterdam yards.

One of the leading Rotterdam firms has recently made considerable extensions, and there are advanced plans for further extensions. Another Rotterdam firm has a big new yard further down the river nearing completion.

One of the largest Rotterdam yards has seven building berths, the longest of which will take a boat of 600 ft. It has three floating docks of 575, 440 and 300 ft. respectively. It has its own foundry, but does not appear to make big castings. A Rotterdam firm which specialises in repairs has four floating docks, of which the largest is 695 ft. long and 142 ft. wide, with a lifting capacity of 46,000 tons. It has a slipway for vessels up to 3,000 tons. At Scheidam, the biggest yard has seven building berths, one of which would take an 800 ft. vessel. It has three floating docks of 10,500, 5,300 and 4,200 tons capacity.

At Amsterdam one of the big firms has eight berths, and can build ships up to 800 ft. The other leading concern, which devotes its activities to repair work, has five floating docks ranging from 401 ft. by 63 ft. to 650 ft. by 100 ft., the latter capable of lifting 25,000 tons.

Dutch competition may be considered from two standpoints. First there is the reality of the competition, as evidenced by the lower wages, longer hours, willingness to put in night shifts and overtime, freedom from union restrictions and demarcation disputes, the employment of low grade and cheap labour on many simple jobs reserved in this country for fully apprenticed men, and the more easy system of municipal rating, which conditions enable the builders and repairers in Holland to obtain a considerable amount of work which, in other circumstances might be done in British yards. On the other hand the competition of Holland is not without its limitations. In the first place, scores of small yards which, between 1916 and about 1920-21, if not later, devoted themselves as far as possible to ocean-going work, partly because the Continental barge traffic was severely depressed, and partly because almost anything that could go to sea commanded a high price, have now, practically without exception, reverted to their original status as builders and repairers of river craft. Only six or seven big concerns are now engaged on ocean-going ships in addition to their river craft work.

Secondly, even with the comparatively small amount of real shipbuilding and repairing now going on in Holland, as contrasted with Great Britain, there is a shortage of skilled labour. The Dutch trade unions report from 5 to 10 per cent. of unemployment, but this relates almost exclusively to the lower grades of workmen attached to the barge-building industry. Even if many more fresh orders could be secured by the big firms it seems probable that the work could not be got through very expeditiously owing to shortage of skilled men. All the skilled and nearly all the semi-skilled are already at work, and putting in many more hours per week than the men here.

But, whilst the limitations of the industry must be recognised, it has to be noted that considerable extensions of plant are being made in the Rotterdam area, and that the unskilled are steadily turning into semi-skilled, and the semi-skilled are passing up into the skilled grade. Men rise, just as well as they work—according to their abilities, without trade union hindrance. Fully apprenticed men do not waste their time or their employers' money on simple processes or mere repetition machine work or rivetting. In Holland the idea is to work, and to get on with the work, to pay by results, with advancement according to ability. Labour units are not confined in watertight union compartments. Dutch employers and managers are generally unstinted in their praise of the workmen, and speak with something akin to disgust at the British trade union attitude.

Turning now for a moment to the physical and technical features of the Dutch yards, before detailing costs and related economic conditions mention may be made of a few facts of a general character. One notable feature of two or three of the Dutch yards is their great area. Some of the establishments in or near the busy parts of the cities are limited for space, but the others occupy a great deal of ground. In one yard employing a thousand men, there is a great deal of room for works extensions. The scattered nature of the works, involving long distances for men and gear and materials to travel between the shops and the stocks, or docks, is neutralised, in at least one big yard, by the employment of a motor conveyance. This runs up and down the main roadways continuously. It not only carries tools, paint, rivets, general small gear and parts, but the men and boys use it extensively to ride from one part of the establishment to another.

A more important feature that strikes the eye is the building up, as far as possible, of sections in the plating sheds instead of on the boats. To some extent this system overcomes unfavourable weather conditions, it keeps both men and materials dry, and it saves a lot of hand riveting. For example, many bulkheads are made completely under the sheds, and then carried to the ships by travelling crane. Even the largest bulkheads are taken to the boats in only two pieces. They are not constructed plate by plate on the ships, as in this country. Even deck-houses are made complete under cover, and largely by machinery, then carried to the ship by travellers. The actual work on the boats, or at the building berths, is minimised. Incidentally, any competent man can rivet, drill, plane, shear, punch, cut, caulk, or do anything, unrestricted by union rules. Individual ability is the only test.

It is mainly in the willingness of labour, and steady application in the will and freedom to rise from low to higher grades of labour, in the free exercise of individual energy and skill, in the absence of trade union restrictions and freedom from paltry demarcation disputes, and in the resultant economy in costs, the speed in execution of urgent jobs, and the easy fulfilment of contract promises, practically free from strikes and "ca'canny," that constitute the chief assets of Dutch industry—and of other foreign industries, compared with British conditions. In Holland two men are not employed to do one man's work. One section of skilled labour does not wait whilst another section performs some little job according to union regulations. Handy men are not condemned permanently to be unskilled labourers just because their fathers did not apprentice them to some trade. Fully apprenticed men are not employed to perform easy repetition jobs. Urgent breakdown work is not held up whilst union officials are consulted.

Turning now to wages and hours, the facts are interesting, but it is only with difficulty that fair comparisons can be drawn between those of Britain and Holland. Reference may first be made to the official report recently prepared for the British Government by our commercial representative at The Hague, Mr. R. V. Laming, O.B.E., in consultation with the Dutch authorities. Particulars are given in this regarding the labour employed by the Association of Metal Industrials in the shipbuilding industry, and are for 23,000 men over 20 years of age. Particulars relating to the 6,000 boys, however, are not given.

The regulations of the Association allow wages to be paid by the employers according to the skill of the employees, provided a minimum average wage is paid to the group in which the labourer is classed, the groups being numbered I., II. and III. for skilled, practised, and unskilled hands. Of the 23,000 labourers concerned, 11,000 are in Group I., 7,000 in Group II., and 5,000 in Group III.

Over and above this grouping into three labour categories, the areas and municipalities where shipbuilding is carried on are divided into four classes. The first class embraces Amsterdam, Rotterdam and Scheidam. The second class takes in the yards of Flushing, Dortrecht, and some others of no great importance for international shipbuilding. The third class consists of the yards of the Kinderdijk and areas along the "Noord." The fourth class takes some of the smaller village yards of which the products have no bearing on the building of sea-going ships.

The minimum average wages fixed—average over the three grades of labour, that is—are 54 cents, 47 cents and 45 cents per hour for area Classes I., II., III. and IV., respectively. The average actual earnings, or hourly incomes, are 64, 62, 56 and 59 cents in the four areas. The difference between minimum and actual is due, of course, to piece-work pay. (Five Dutch cents equal one English penny.) The figures are for the first half of 1924.

Coming to overtime, the report says that, according to the regulations of the Association, 25 per cent. extra must be paid for overtime during two hours before and two hours after the 10-hour shift, but in practice overtime is usually paid before and after the 8-hour day, although in some cases the overtime for the first two hours is only 12½ per cent., the increase being brought up to 25 for the first two hours after the 10-hour shift, or for the third and fourth hours after the 8-hour day. After the first two hours after the 10-hour day, or after the first four hours after the 8-hour day—that is, for night work—50 per cent. extra is paid. Sunday and holiday work is paid 50 or 100 per cent. extra according to circumstances. Amsterdam still retains the 48-hour week, and objects to overtime and night work; but Flushing works 52 hours per week; and the Rotterdam area either 55 or 56½ hours, plus overtime and night shifts when required.

At Rotterdam the night shift works from 6 to 6, with two hours for meals. Some of the day men also work from 6 to 6, with two hours' interval; but most of the day men seem to work from 7 to 6, with 15 minutes for breakfast and 45 minutes for dinner.

The general Eight Hours Law, carried some time after the war, was soon found uneconomic in Holland, and it has been abandoned, save in the Amsterdam area. In the area with which we have to compete, viz., Rotterdam and Scheidam, the hours are, as stated above, either 55 or 56½ per week, plus overtime when required. The men do not object to, but welcome, the overtime. As the law stands it is necessary to obtain Government permits to exceed the 48-hour week, but such permits, running for six-month periods, are readily secured. One employer expressed the fear that, although the trade unions, as such, would not demand reduced hours or the withdrawal of the extra time permits, some of the politicians might raise the subject as an issue in the coming General Election.

One employer, who secures much British ship-repairing, has stated that he employed 3,000 men regularly before the Eight Hours Act was carried. Under the 8-hours' system with its three shifts, his competitive power was so weakened that he soon had his working staff reduced to 800. Since the men have consented to go back to the 10-hour day, with double shifts as required, he has got his staff back to 3,000. This employer also has a large yard approaching completion farther down the river. His old plant cannot be materially extended, and it is operating at about full capacity.

The impression left on the mind after carefully inspecting British and Dutch conditions is that our trade unionism largely defeats its own object—*i.e.*, the improvement of the living standard of the workers—for it is responsible for the loss of much work and money, whereas Dutch labour takes the real business view and works accordingly. The leaders appear to be actuated by a very moderate spirit, while the methods and disposition of the men seem to be quite satisfactory. Employers and managers always spoke of the workers in high terms.

Besides the labour advantage, the Dutch employers have a large advantage over the British in the matter of rates and taxes. Local rates and national taxes are collected by the same staff in Holland, to save expense. The taxation (including that levied on municipal account) is excessive in Holland, but the method of levy is far better there than with us here. The Dutch principle is to tax only according to ability to pay—according to income and style of living. The result of this is that the shipbuilders and repairers who have lately taken jobs at unprofitable prices, to keep men and plants going, are paying little or no municipal rates, whilst our people are severely rated regardless of industrial economics.

* This concern is being taken over by the Rotterdam Dry Dock Company.

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Courses of Lectures in Mining and Metallurgy.—The University of London has organised two special courses of lectures on subjects of interest to students of metallurgy and mining. In the first of these Professor C. A. Edwards, of University College, Swansea, will lecture on "Chemical Combination in Metallic Alloys and its Nature," the meetings for which will be held in the Imperial College, Royal School of Mines, at 5.30 p.m., on Tuesdays, March 3 and 10, and Wednesdays, March 4 and 11. Professor L. Denoël, of the University of Liège, will deliver the second course, which will concern "Tubbing Deep Shafts" and "Subsidence." These lectures will be delivered at 5.15 p.m. in the Mining Department of the same institution on Monday to Thursday, March 16 to 19. Admission is free—without ticket—in both cases.

# ANTI-FRICTION BEARING APPLICATIONS FOR HEAVY DUTY.*

By J. B. DAHLERUS.

(*Concluded from page* 210.)

*Continental Practice*: *State Railways in Finland.*—On the State Railways in Finland, 56 axle-boxes of a design similar in character to that shown in Fig. 4 were fitted during June and July, 1923, each box having one spherical roller-bearing 90 mm. bore by 190 outside diameter and 64 wide, and one cylindrical roller-bearing 105 mm. bore by 225 outside diameter and 49 wide; 48 of these boxes were mounted in six bogie-carriages weighing 34 tons to 36 tons each, and eight boxes in two two-axle luggage vans weighing 10 tons. These carriages and a dining-car on plain bearings weighing 40 tons have been kept together in a train running between Helsingfors and Abo.

A distance of 200 km. (124·27 miles) is covered once each day and six days per week. The maximum speed on the line is approximately 50 miles per hour, but 43½ miles per hour is seldom exceeded. The line has many curves and gradients, and the maximum gradient is about 12 in 1,000. During the period of September 1 to October 21, the drivers of the respective locomotives have kept records regarding the quantity of coal loaded on the tender, after each trip, the results being as shown in Table 5.

TABLE V.

| Train. | Axle Miles. | | Coal Consumption. | |
|---|---|---|---|---|
| | Roller Bearings. | Plain Bearings. | Total Lb. | Lb. per 1,000 Axle Miles. |
| 1 | 82,275 | 13,170 | 82,830 | 1,000 approx. |
| 2 | — | 75,065 | 71,390 | 952 ,, |

The coal consumption for the plain-bearing axles in the roller-bearing train was thus 13·17 multiplied by 952 = 12,540 lb. Therefore, there is a remainder of 70,290 lb. for the roller-bearing axles, which corresponds to 854 lb. per 1,000 axle-miles. The saving per 1,000 axle-miles will thus be 10·3 per cent. During this period the records of one of the drivers indicated that the saving is increased as the driver gains experience with the roller-bearing train and finds the most economical way of driving it. During the first week with plain bearings, the average coal consumption was 3,785 lb., and with roller-bearings, 3,410 lb., representing a saving of 10 per cent. During the second week the result was 3,610 lb. with plain bearings, and 3,170 lb. with roller-bearings, representing a saving of 12 per cent. No correction is made in these two cases for the plain-bearing axles in the roller-bearing train. The plain-bearing train consumes on an average 102 lb. per 1,000 ton-miles and the roller-bearing axles 90 lb. After correction for the four plain-bearing axles in the roller-bearing train, the saving works out at 11·5 per cent.

*Swedish State Railways.*—On the Swedish State Railways 1,366 axle-boxes of a design similar to that indicated in Fig. 4, have been fitted. Each box has one spherical roller-bearing, 90 mm. bore by 190 outside diameter and 64 wide, and one cylindrical roller-bearing 105 mm. bore by 225 outside diameter and 49 wide, the load on each axle-box being 5½ tons.

* Paper read before the Institution of Mechanical Engineers on Friday, February 6, 1925. Abridged.

The preliminary tests commenced about 1919, and after experiments along various lines, the design mentioned was finally adopted. With this design, tests were carried out for economy, and although full details are not available for publication, it may be stated that the Swedish State Railway engineers found that the fuel saving was between 13 per cent. and 14 per cent. It was after these preliminary tests that the large number of boxes mentioned above was installed.

Apart from the data given above, the following figures may be of general interest:—In Great Britain, 116 axle-boxes have been supplied and are in service. In Australia, four axle-boxes are in service. In America and on the Continent, including France, Sweden, Germany, Denmark, Finland, Japan and Czecho-Slovakia, there are over 3,000 axle-boxes in service. An average figure for the cost of these roller-bearing boxes is about 20*l.* each, complete with bearings and fittings, but, of course, this varies with the size of the box and with the quantities which are required of any given design. This figure as to cost has been inserted to give the engineer some idea on which to base preliminary estimates if he is so interested.

*Tramway Work.*—With the development of the heavier types of roller-bearings described, interest centred round applications to tramways. The arrangement referred to in this paper has the great advantage of being a simple two-bearing unit and the only complication which arises is in the method of providing suitable protection, particularly at the pinion end. A design which has found favour and has been proved thoroughly practical is shown in Fig. 11, and as the construction is clear from the illustration there is no need to make special reference to it.

*Fig. 11.* TRAM MOTOR.

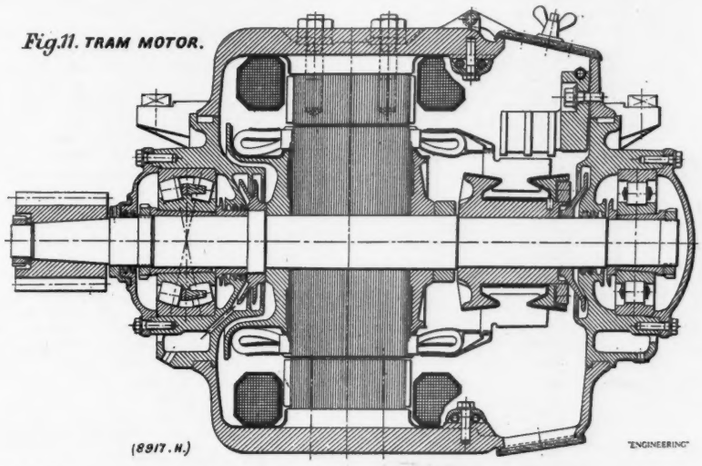
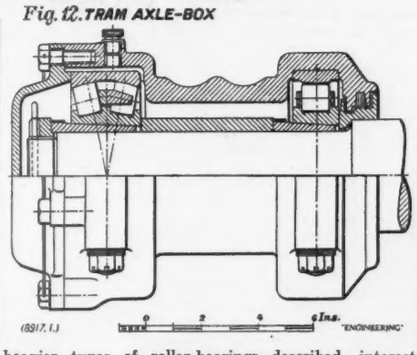



*Fig. 12.* TRAM AXLE-BOX.




It would be difficult to determine exactly what economy in power saving could be obtained from this application, but the advantages of being able to keep the armature centred accurately in the magnetic field and also preventing the disastrous results due to the armature dropping and fouling the pole pieces are more or less self-evident. Many hundred of motors have been so equipped.

*Axle-boxes.*—Tramway axle-boxes in common with railway axle-boxes, have had their share of attention as regards roller-bearing design, and two typical arrangements have been developed. As is well known, the axles have to be removed fairly frequently for the purpose of re-tyring the wheels, and the nature of this operation is such that it is necessary to remove the bearing-boxes. To facilitate the removal of the boxes, designs have been tried with special sleeve mounting fitting on the taper end of the axle. This, however, necessitated comparatively large bearing-boxes, and as the outside dimensions of the box were restricted it meant using comparatively light types of bearings. Such a design has not proved satisfactory, the chief trouble developing arising from the locking arrangement for the sleeve being somewhat unsound in design. It is indeed difficult to arrange for a sound locking scheme on account of restrictions regarding the overall dimensions over the boxes. Eventually, the design as shown in Fig. 12 has been developed. This permits of a sound method of mounting and the use of medium type bearings. This design is being tested at present, and so far it would appear that it has overcome the chief difficulties.

Economy in power is probably the most important feature here, and to determine to some extent what might be expected, two different bearing manufacturers have had very careful and exhaustive tests carried out for them by the National Physical Laboratory. The details are very complete and would take up more space than is available here, but the chief results are given below.

*Glasgow Test.*—This test was conducted by the National Physical Laboratory in May, 1923, a comparison being made between a car fitted with one double row spherical roller-bearing and one cylindrical roller-bearing per axle-box, and also on the motors—against a car fitted throughout on plain bearings. The axle-boxes were of the Brill type, and have the sleeve mounting for the bearings as previously referred to. The car, which was of the Glasgow Corporation standard double-deck, roof-covered type, mounted on a single truck, had a seating capacity for 62 persons. It was driven by two motors, of 39-h.p. each, and operating on the single trolley system. The power was transmitted from the motors to the axles through single reduction spur gearing which was entirely enclosed.

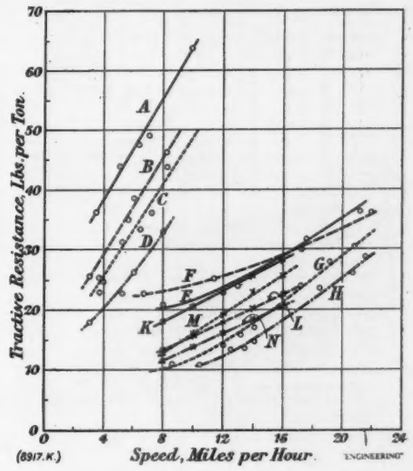



FIG. 13. TRAMCAR RUNNING RESISTANCE CURVES.

| | | Tons. | Cwt. |
|---|---|---|---|
| A. | Wigan test plain bearings. Empty .. | 10 | 10 |
| B. | ,, ,, ,, Loaded .. | 14 | 10 |
| C. | ,, Roller ,, Empty .. | 10 | 10 |
| D. | ,, ,, ,, Loaded .. | 14 | 10 |
| E. | L.C.C. test Plain Bearings. Empty .. | 15 | 17 |
| F. | ,, ,, ,, Loaded .. | 20 | 14½ |
| G. | ,, Roller ,, Empty .. | 15 | 17 |
| H. | ,, ,, ,, Loaded .. | 20 | 14½ |
| K. | Glasgow test plain bearings. Empty .. | 11 | 15 |
| L. | ,, ,, ,, Loaded .. | 15 | 15 |
| M. | ,, Roller ,, Empty .. | 11 | 15 |
| N. | ,, ,, ,, Loaded .. | 15 | 15 |

Tests were made in the first place on the car as ordinarily fitted with plain bearings, and secondly, on the car after conversion to roller-bearings of the type described. As it is obvious that needless space would be taken up in the paper by a description of the apparatus used and all the various details of the test, only a summary of the results obtained is now given.

(1) The percentage saving of electrical energy in favour of the roller-bearing car was definitely determined as 11·62 per cent. on the average, the minimum being 0·6 per cent. for one small section of the run, and a maximum of 17·5 per cent. in another section.

(2) The tractive resistance at half-load and at an average speed of 8 miles per hour gave a reduction of 22·6 per cent. in favour of the roller-bearing car, 29·6 per cent. when unloaded, and 14·9 per cent. on full load. At 16 m.p.h. the reduction at half-load was 8·4 per cent., unloaded 8·9 per cent., and on full load 8·4 per cent.

(3) The starting effort for various loads indicated an average reduction of 79 per cent.

(4) Coasting tests were made on an up gradient of 1 in 730, and although the track was not sufficiently

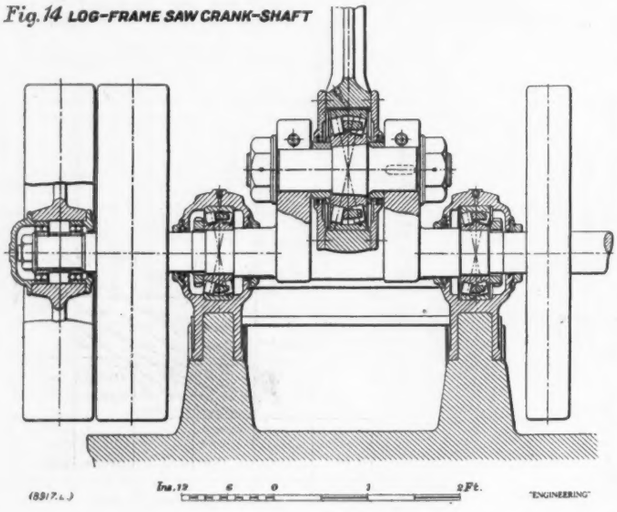
good for the test owing to the gradient not being uniform, the following approximate results were obtained :—

Retardation of plain-bearing car = 0·49 ft. per sec.$^2$
Retardation of roller-bearing car = 0·32 ft. per sec.$^2$

The percentage greater distance run by the roller-bearing car from the moment the current is shut off at any particular speed, before the speed is reduced to the same value in each case, is 53 per cent. As a matter of interest, Fig. 13 is included, which gives a ready comparison between this and other similar tests which have also been carried out by the National Physical Laboratory. The graph, with the accompanying notes, is self-explanatory.

*Log Frame Saws.*—Log frame saws of the modern type have several saw-blades in series, mounted in a suitable frame made to slide up and down within the main frame of the machine by means of a crank and connecting rod. The type which is of particular interest here is the single-crank type, and Fig. 14 illustrates a bearing arrangement which has been found effective. In the development of this design, many unlooked-for troubles were met with, apart from the capacity of the bearing itself, but up to the end of 1923 actually ninety-five bearings for the crank-pin have been supplied to manufacturers of these machines in Great Britain, Sweden and Germany. The size of the crank-pin bearing, which is of the spherical double row roller type, is as follows :—Bore, tapering, 140 mm. diameter at the smallest end. Outside diameter, 390 mm. Width, 120 mm.

*Fig. 14* LOG-FRAME SAW CRANK-SHAFT




It will be seen from the drawing that the crank-shaft is divided, so that the mounting of the crank-pin bearing can be carried out without having to pass the bearing over the crank-webs. The crankshaft is supported in two other spherical roller-bearings, and is driven by means of the pulley shown. The general experience of the crank-pin bearing in this application has shown that, while running, the temperature attained with a new bearing is between 40 deg. and 50 deg. C., but, after the bearing has been running for a short time, the temperature drops to about 30 deg. C. This experience is a little contrary to what is usually found, but it will be clear that the conditions of operation are also unusual, so that a direct comparison between an application of this kind and that of the usual character met with in general engineering, cannot be made.

*Rolling Mills.*—It will be admitted that the loads on rolling-mill bearings are, perhaps, the most severe to be found in the whole field of engineering, particularly considering the speed and the nature of the material which is being handled. The difficulties in connection with this particular application are very great, and while for certain classes of work satisfactory bearings are available, there still remains the question of the roll trunnions and housings. Fig. 15 shows the application of these bearings to a three-high 10-in. mill, which illustrates the general principles of the application. The following are the chief features :—

(1) The roll spindles are specified as having an ultimate tensile strength of 100 tons per square inch, and that the rolls should be shrunk on to the spindles.

(2) By making the bore of the bearing tapered, the strength of the axle is kept at a maximum, and easy removal of the bearing is facilitated.

(3) The inner protecting ring is made as a nut, so that by putting a suitable spanner on it, the inner ring of the bearing is easily loosened on the shaft, of course, after having released the outer clamping nut.

(4) In this particular mill, the top and bottom rolls are fixed laterally, and adjustment to obtain registration of the roll grooves is effected by the adjusting screws indicated on the centre bearing housing.

(5) The bearing housings are made of cast steel.

In other types of mills it may be necessary to introduce a special thrust-bearing on the adjusting rolls, and in other cases it may be necessary to stagger the journal bearings, so as to obtain the maximum bearing sizes possible.

*British Practice.*—In ENGINEERING of November 7, 1924, a reference is made by Mr. C. E. Davies to experiments being carried out with these bearings on sheet rolling mills by Messrs. W. H. A. Robertson and Co., Limited, in collaboration with the Skefko Ball Bearing Co., Limited, Luton. It is perhaps too early as yet to predict where these experiments will lead, although it may be said that they are exceedingly promising, and the following details regarding the tests for economy should be of interest.

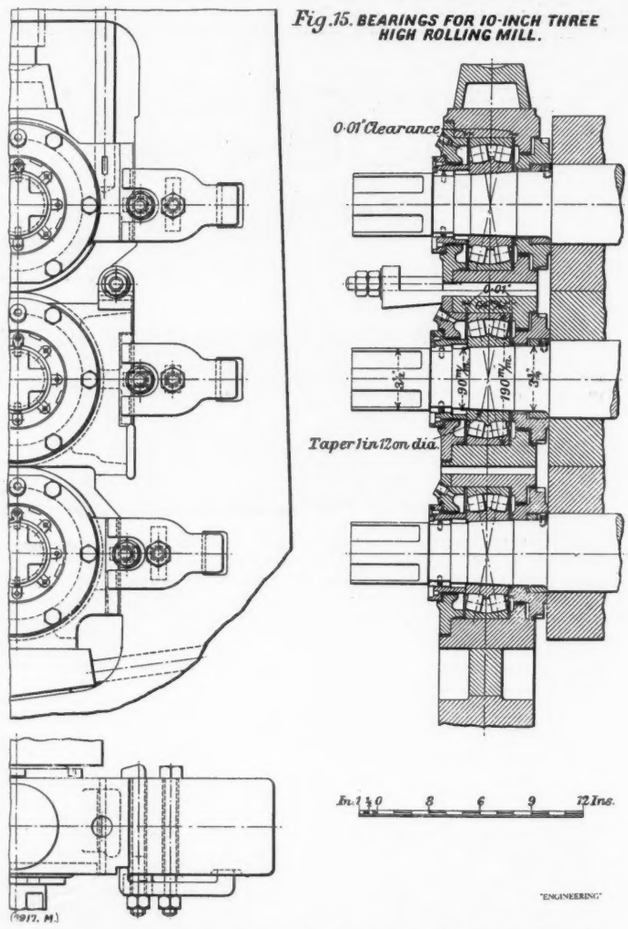
Two mills with 8-in. diameter rolls were tested, one fitted with spherical roller-bearings (90 × 190 × 64 millimetres, rated capacity approximately 15½ tons), and one fitted with ordinary bearings. The speed of the rolls was 48 r.p.m., and the rolling speed 84 ft. per minute. The metal rolled was common brass strip, annealed, the width of strip being 5⅝ to 5¾ in. The thickness before rolling was about 0·03 in., and the reduction per pass was on an average 0·01 in. In the roll fitted with the roller-bearings, a quantity of about 5 cwt. was put through during a test period of about 1 hour. The same quantity of material was rolled in about the same time in the mill on ordinary bearings. A comparison of the power taken in both cases was made with an electric meter, in which the revolutions of the meter disc were counted. With ordinary bearings the revolutions of the disc were 202, and with roller-bearings 137·5, thus indicating a saving of 31·7 per cent. under actual working conditions. During some parts of the test a saving of 50 per cent. was indicated. It is also to be noted that with the ordinary bearings the power increased from the beginning to the end of the trial due to heating of the bearings, so that if the trial had been continued for a longer period, the average power consumption would have been increased, while with the roller-bearings no increase with time occurred. Further trials have indicated an average saving of 43·5 per cent.

A 2-high wire finishing mill has also been equipped by Messrs. Richard Johnson and Nephew, Limited, Manchester, which has been found very satisfactory. There are some interesting points about this particular mill, which are as follows :—The rolls and journals were originally of cast-iron, and in converting to roller-bearings, it meant reducing the journal diameter from 6 in. to about 90 mm. at the bearing seating. It was originally thought that this severe reduction would mean eventual trouble with trunnion breakages, but although the original mill has been running since early in 1923, it has so far given no cause for anxiety in this respect. The speed of the rolls is 1,000 r.p.m.

*Continental Practice.*—In the periodical *Stahl und Eisen*, No. 16, 1924, appeared an article by D. C. Holzweiler, of Wiesdorf-Koln, dealing with the layout of the plant at Witkowitz Ironworks. This described in particular tests on three finishing stands in a mill with six roughing stands and six finishing stands. The details are given very fully in the periodical referred to above.

The paper concludes with details of a number of further applications of a general nature, examples being given of bearings for a rolling mill fly-wheel, maize flaking rolls, a heavy rope pulley, rotary coverters, paper calenders, and a steam engine crank-pin. Other machines in which these bearings have been successfully applied include :—Ball mills ; tube mills ; pulp beaters for paper making ; pulverisers ; disintegrators ; chocolate refining rolls ; an alternator of 2,500 kw. at 1,000 r.p.m. ; 3-bearing rotary converters ; road wheels of motor-omnibuses ; and cross rolls in steel plant.

*Fig. 15.* BEARINGS FOR 10-INCH THREE HIGH ROLLING MILL.




THE INSTITUTE OF METALS.—The Journal of the Institute of Metals for the second half of the year 1924 has been recently published and may be obtained from the Institute, 36, Victoria-street, London, S.W.1, at a price of 31s. 6d. net. Edited by Mr. G. Shaw Scott, the book contains amongst much other material 14 papers presented at the London meeting held in September last year, together with full accounts of the May lecture on "Atoms and Isotopes" delivered by Dr. F. W. Aston and the autumn lecture given by Mr. W. Corse, the American metallurgist, on "Developments in Non-Ferrous Metallurgy in the United States." The papers were noticed in our columns at the time of their presentation and we would further add that the information that a very complete account of the Seventh Report of the Corrosion Research Committee covering 180 pages is also included in the volume. In particular the discussion of the rusting of condenser tubes under this heading is worthy of attention.

# SMALL TOOLS FOR MACHINISTS.

CONSTRUCTED BY THE BROWN AND SHARPE MANUFACTURING COMPANY, ENGINEERS, PROVIDENCE, R.I., U.S.A.

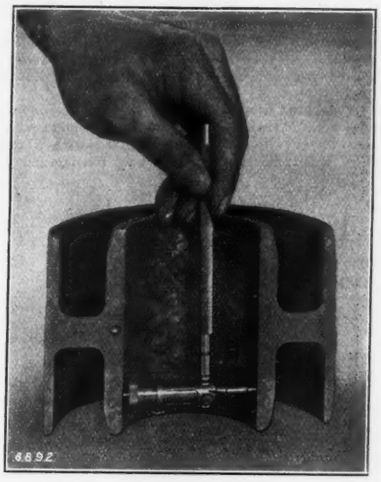


FIG. 1.

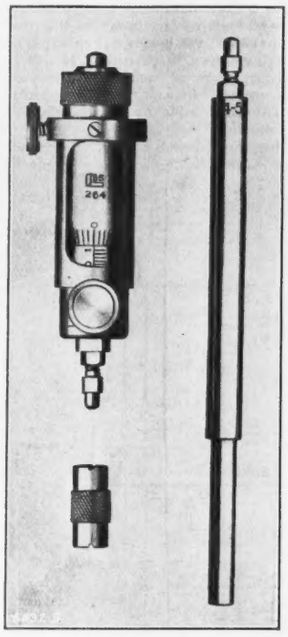


FIG. 2.

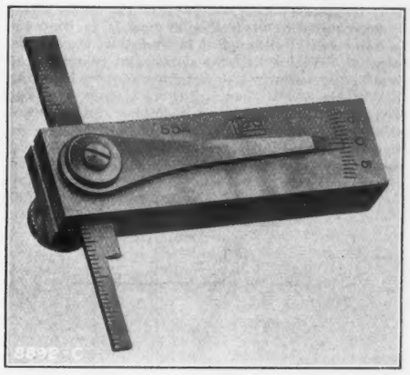


FIG. 3.

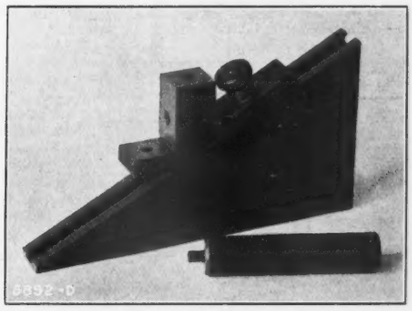


FIG. 4.

## SMALL TOOLS FOR MACHINISTS.

SINCE a considerable proportion of the machinist's time is occupied in the use of small tools and measuring appliances, the provision of suitable equipment of this class has a material effect upon the output of the machine shop. As is well known, the Brown & Sharpe Manufacturing Company, of Providence, R.I., U.S.A., have specialised for many years in the manufacture of tools designed to facilitate the work of the machinist, and their products have achieved a high reputation for accuracy and efficiency in this country, as well as in the United States and elsewhere. The illustrations on this page and the particulars given below of some of this firm's recent productions should therefore be of interest to those responsible for the small-tool equipment of modern engineering works.

The first example, illustrated in Figs. 1 and 2, is a new design of internal micrometer particularly adapted for motor-car work, such as the measurement of cylinder bores, the internal diameters of rings, holes, &c. It consists of a holder, incorporating a micrometer screw, and a series of extension rods by means of which internal diameters ranging from 2 in. to 8 in. can be measured in thousandths of an inch. The holder, as shown in the upper left-hand portion of Fig. 2, is provided with a clamp, which holds the thimble and prevents the screw from turning when the instrument is in use. The micrometer screw has a range of $\frac{1}{2}$ in., and the extension rods, six of which are supplied with the instrument, increase in length in steps of 1 in., but a $\frac{1}{2}$-in. spacing collar, also provided, enables the whole of the above-mentioned range to be covered. One of the extension rods is shown on the right of Fig. 2, and it will be seen that it is turned down at one end to form a shoulder. A rod of a suitable length is inserted and clamped in the holder, so that this shoulder bears against the micrometer head, or, if the required dimension cannot be reached in this way, the $\frac{1}{2}$-in. spacing collar, shown in the bottom left-hand corner of Fig. 2, is slipped on the extension rod so that it comes between the shoulder and the micrometer head. The working ends of the extension rods are hardened, and they are designed so that they can readily be adjusted for wear. In Fig. 1 the micrometer is shown held in a special handle, so that it can be used for measuring small holes in which the hand cannot be inserted. The handle has a hocked end fitting round the body of the micrometer, and a brass plug is forced against the latter, clamping the handle tightly without injuring the tool. By turning the handle round it is locked in position ready for use.

The tool illustrated in Fig. 3 is a die-maker's square, the blade of which can be set to any angle up to 8 deg. on either side of the right angle, so that the necessary die clearances can be easily and quickly obtained; pattern makers may also find this square useful in their work. The blade is graduated for 1 in. from both ends, in 32nds of an inch on one side and in 64ths on the other side; one end is also reduced, as shown, to $\frac{7}{64}$ in. in width, so that it can be inserted in small holes and in narrow dies. The body of the square, which is hardened and ground, measures $2\frac{1}{4}$ in. long, $\frac{5}{8}$ in. wide and $\frac{3}{8}$ in. thick.

Fig. 4 shows a useful gauge designed to facilitate the setting of the cutting tools of planers and shapers to some given height above the table. As will be seen, it consists of a triangular block of hardened steel, on the inclined edge of which slides a stepped block that can be fixed in any position by means of a clamping screw. With the aid of a micrometer, surface gauge or calipers, one of the horizontal surfaces of the stepped block can be adjusted to the required distance above the base, and when this has been done the gauge is placed on the work table of the machine and the cutting tool is brought down into contact with the horizontal surface. The height of the tool above the table is then, of course, equal to that to which the gauge has been set. The cylindrical extension piece, shown in the foreground of Fig. 4, is provided to increase the range of the instrument, this part being screwed into one of the tapped holes in the sliding block, as required. In this way the gauge can be adjusted to give a tool setting ranging from $\frac{1}{4}$ in. to $8\frac{1}{2}$ in. above the table.

One other appliance, to which reference may be made in conclusion, is of such a simple character that an illustration of it is scarcely necessary. It consists of a set of 10 tapered blocks of tool steel, hardened and ground to close limits, any pair of the blocks being used together, on the principle of the folding wedge, to determine the diameters of small holes. One face of each block is curved to form part of a cylindrical surface, the opposite face being flat. A suitably selected pair of blocks arranged to form a folding wedge, is placed in the hole to be measured, and by sliding one block over the other the curved outer faces can be pressed into line contact with the opposite sides of the hole. The diameter of the latter can then be determined by taking a measurement with a micrometer over the curved surfaces of the parts of the blocks projecting beyond the hole. The set of 10 blocks covers all sizes between $\frac{1}{4}$ in. and 1 in., and an engraved metal plate, attached to the lid of the box containing them, shows at a glance the range of sizes covered by each pair.

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ALUMINIUM-TUNGSTEN ALLOYS.—The primary difficulties in preparing alloys of aluminium (and of copper-aluminium alloys) with tungsten, are the great differences in their densities, 2·7 and 18·8, and in their melting-points, 657 and 3,267 deg. C. M. R. Whitmore and F. T. Sisco, experimenting with such alloys on behalf of the Air Service of the United States War Department find that they are not of great promise for this reason and also because the tungsten, which acts as a hardening element, is not affected by ordinary heat treatment. The alloys prepared, according to the *Industrial and Engineering Chemist*, consisted of aluminium, 10 per cent of copper and 1·25 per cent. of tungsten. When the tungsten was added as powder or in cubes to the aluminium, fused in an Ajax induction furnace pre-heated to 1,370 deg. C., there was always bad segregation; utilisation of the heat reaction resulting when aluminium and copper, separately fused, were mixed, was likewise unsatisfactory, and so was reduction of tungsten compounds by the aluminium. The final product was obtained by re-melting the first-prepared, more or less segregated alloys, in oil-fired plumbago crucibles and proving at 1,010 deg. C. The heat treatment in electric muffle furnaces hardly altered the structure and properties of the alloys.

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INFLUENCE OF OXYGEN ON MILD STEEL.—Owing largely to analytical difficulties, there are very few reliable quantitative records on the influence of the presence of oxygen on the physical and technical properties of mild steel. Dr. Ing. A. Wimmer, of Dortmund (*Stahl und Eisen*, January 15), working on this subject, prepared specimens by melting a soft steel (with 0·05 per cent. of carbon, 0·38 per cent. of manganese and about 0·04 per cent. of phosphorus and of sulphur) in an electrically heated crucible lined with magnesia, superheating the melt by about 50 deg. C., removing all slag and adding weighed iron oxide so as to introduce up to 0·2 per cent. of oxygen, determined by the method of Oberhoffer. The charges of about 9 kg. were forged into bars. The elastic limit, tensile strength, and impact strength, elongation, contraction and Brinell hardness were found to decrease decidedly as the oxygen content increased. The shortness of the steel at red heat became pronounced with 0·15 per cent. of oxygen; in the cold the specimens became brittle even with 0·13 per cent. of oxygen; they were less easily machined and stood up to cold work and especially rapidly changing stress, badly. The size of grain seemed to increase with the oxygen percentage. These results do not quite agree with practical observations, in which, however, the influence of other impurities and of treatment are difficult to eliminate. It is believed that well-deoxidised iron will not contain more than 0·08 per cent. of oxygen, while this percentage may be doubled under ordinary conditions. There seems to be little doubt that oxygen is a highly detrimental constituent of iron.

## TREPANNING AND BORING TOOLS.

THE operation of trepanning subjects the cutting tools to unusual stress, due to the fact that the material to be operated upon is generally tough steel, which is frequently used in cases where castings of either iron or steel would be of doubtful reliability. Coupled to this is the unavoidable overhang of the tools, which may be required to cut a piece of steel 12 in. deep out of a solid block, although it is advisable, when practicable, to machine half the depth and complete the operation by turning the work over to cut from the opposite side.

To meet these difficulties a heavy and powerful machine tool is required, equipped with strongly designed cutter heads, and preferably with several tools cutting at once to give a smooth action under a heavy feed. An ample supply of cutting compound should be provided and delivered under pressure direct to the cutting edges of the tools.

The vertical boring machine is the most convenient type of machine tool for trepanning many classes of work, as, for example, the ends of connecting rods, but in some cases a horizontal boring and facing machine can be used with advantage. Machines of this description, when designed for occasional use for trepanning operations, are often provided with a special fine feed of 200 cuts per inch in addition to the usual range, and perform the operation by means of a large tool box bolted on to the facing head. The revolving table usually found on these machines readily allows the work to be moved through half a revolution to complete the trepanning, after cutting half-way through. This is an advantage not possessed by a vertical machine. An example of the time taken on a boring and facing machine for trepanning a hole 14 in. diameter, using a single tool with a feed of 200 cuts per inch, is two and a-half hours to cut through a steel block 12 in. deep, the centre-piece cut-out being 12 in. diameter.

While the heavier class of engineering work does not admit of multiple tooling operations being carried out with the same ease as in the case of small components, there are many examples where tools can be mounted to follow successively, or work in conjunction with each other, thus saving re-setting and considerably reducing the time which would otherwise be taken for the operation.

Figs. 1 to 4 show details of a trepanning head for connecting-rod ends having bores ranging from 6⅜ in. to 11⅜ in. diameter, the boring bar carrying the finishing tools being shown in position. It will be understood that the latter is removed for the initial trepanning operation. Figs. 5 to 8 show similar details for a smaller head suitable for holes ranging from 5⅞ in. to 6¼ in. diameter.

Two trepanning heads are fixed on the ends of the spindles of a duplex vertical boring machine, and operate together on a pair of connecting rods. The heads are driven by two cotters passing through the spindles, and each head, except the smallest size, carries three cutting tools. A feed of 100 cuts per inch is used for trepanning in this case. The spindles of the machine are 4¼ in. diameter in the bearings, and are bored out full length to allow cutting compound to be forced through them on to each of the tools by means of brass tubing fixed in the tool head. Each tool is firmly held in position by two screws at the front and two at the side, as shown. By means of a steel packing piece, shown behind the tool, an adjustment of approximately 1¼ in. in diameter can be obtained for each size of head. After the trepanning operation is completed, the heads are left in position, and two boring bars carrying cutter heads are attached to the spindles. Provision is made to pilot the bars by means of steel bushes, fixed in the machine table as shown. Two tools in each head are arranged for the finishing cut, and lubrication is provided for by fixing bevelled sheet-brass covers on the boring heads so as to deflect the cutting compound coming down from the three tubes on the trepanning heads.

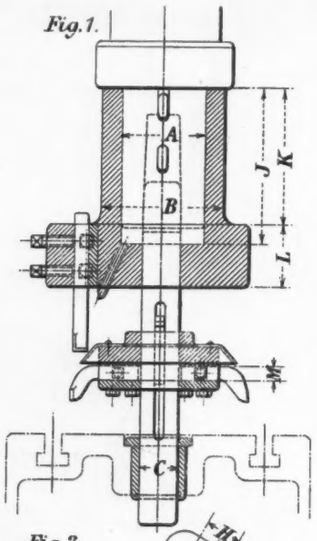
The list of proportions given in connection with Figs. 1 to 8, is for a range of trepanning and finish-boring tools of the type described, for holes between 5⅞ in. and 11⅜ in. in diameter; all of these have been successfully used in actual practice.

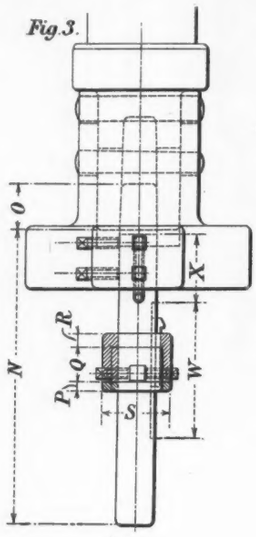
An example of tool equipment designed for rapid production is given in Figs. 9 and 10, which show a multiple tool head arranged for trepanning, boring, and chamfering a 10¼-in. diameter hole through a steel plate 3 in. thick, for an internal reduction gear. In this case a hole is bored through each plate before trepanning, so that the centre piece cut out can be utilised as a pinion blank by simply trueing the outside diameter.

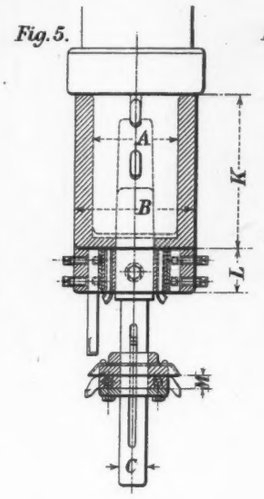
The machine used for these operations is somewhat similar to the two-spindle boring machine previously described, but in addition it is fitted with a three-station turntable carrying suitable fixtures to hold the work. The sequence of operations is as follows:—The operator places a steel plate in the first fixture, and the table is revolved through 120 deg., which brings the fixture under the cutting head, Fig. 9. The centre of the plate being removed, as stated above, allows the boring bar to be piloted so that several operations can be performed together without undue stress or vibration. In the meantime another plate is placed in the second fixture, and a further circular movement of the table locates this under the cutting head, at the same time taking the first fixture under the second spindle for the finishing operation, and afterwards to the removal and reloading position at the front of the machine.

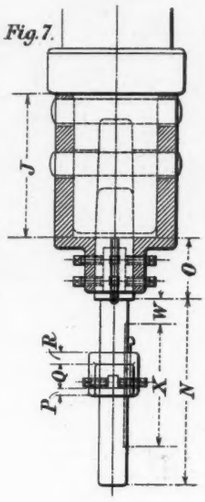
Referring to Figs. 9 and 10, it will be noticed that this head is clamped to the bar by a substantial bolt and socket, and that four tools can be carried if required. The trepanning tool is set slightly in advance of two boring tools, and a chamfering tool comes into operation at the end of the traverse. The pilot bush is arranged with felt wiper and dust cover for protection from cuttings.

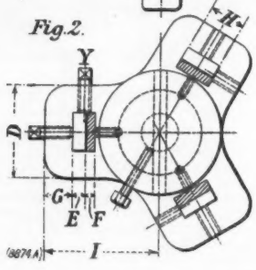
Figs. 11 and 12 show a type of floating cutter for finishing the bores. A strong bar is used to support the cutters, which are adjusted to diameter by the screw shown, and allowed to float for a limited distance by screws fitting in slots at the side of the cutters. An alternative method of finishing the bore is by a floating reamer, as shown in Figs. 13 and 14. This is for a 6-in. bore, and is driven by means of a 4-in. diameter bar fastened to the spindle. Floating connection between the reamer and the bar is attained by a coupling of the Oldham type. Eight blades are shown in the reamer, although 10 are frequently used. On the question of regular or irregular spacing there is a difference of opinion, but in the case under

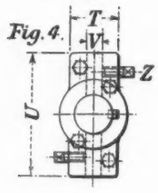


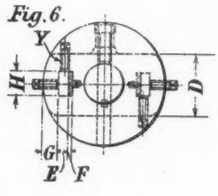



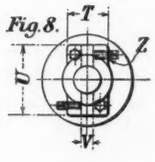



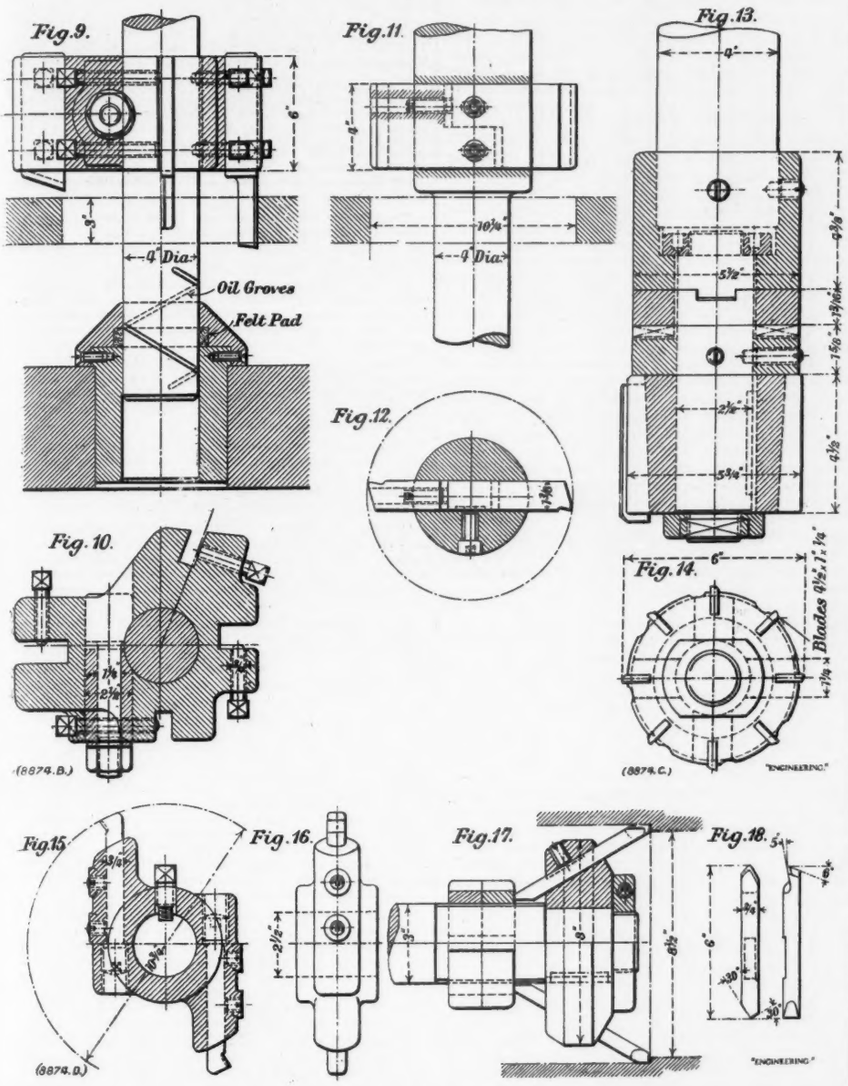




Proportions for Trepanning and Finish Boring Tools. (Figs. 1 to 8.)

| Diameter of Hole. | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| In. In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. |
| 5⅞ to 6¼ | 5½ | 8 | 1½ | 4 | ⅜ | ¼ | 1 | 1½ | 4 | 9½ | 10 | 2¾ | ⅜ | 12 | 4 | ½ | 1½ | ⅜ | 3½ | 2¾ | 4½ | ¾ | 1½ | 8 | ½ | ⅜ |
| 6⅜ to 7¼ | 5½ | 8 | 1½ | 5½ | ⅜ | ¼ | 1⅛ | 2½ | 5 | 9½ | 8¾ | 4 | 1 | 12 | 4 | ⅝ | 1⅛ | 1 | 3½ | 3 | 5½ | 1 | 1½ | 8 | ⅝ | ⅜ |
| 7⅜ to 8¼ | 5½ | 8 | 2½ | 6 | ⅜ | ⅜ | 1⅛ | 2½ | 5½ | 10 | 8¾ | 4 | 1 | 19 | 3½ | ⅝ | 2 | ¾ | 4½ | 3½ | 6½ | 1 | 4½ | 9 | ⅝ | ⅜ |
| 8⅜ to 10¼ | 5½ | 8 | 2½ | 6 | ⅜ | ¼ | 1⅛ | 2½ | 6½ | 10 | 8¾ | 4 | 1 | 19 | 3½ | ⅝ | 2¼ | ¾ | 4½ | 3½ | 7½ | 1 | 4½ | 9 | ⅝ | ⅜ |
| 10¼ to 11¼ | 5½ | 8 | 2½ | 6 | ⅜ | ¼ | 1⅛ | 2½ | 7⅛ | 10 | 8¾ | 4 | 1 | 19 | 3¼ | ½ | 2½ | ⅞ | 4⅛ | 3½ | 8 | 1 | 4¼ | 9 | ⅝ | ⅜ |

## TREPANNING AND BORING TOOLS.







consideration the latter method gives satisfactory results.

Boring tools with a good range of adjustment are shown in Figs. 15 to 18. The type of head given in Figs. 15 and 16 carries two tools of circular section with separate adjustment for each. Two safety-type set screws are used for locking the tools in position, and, due to spring action, a very fine finish can be obtained.

In the example shown in Figs. 17 and 18 eight tools of circular section are used. Adjustment is by two lock nuts fitting on a fine thread on the bar, and bearing against the ends of the tools, which are bevelled as shown. Flats on the tools prevent rotation when adjustment is made, and provide a bearing for the locking screws. The head is simple to construct, and the size given is very efficient for bores from 8 to 10 in. diameter.

## NOTES ON NEW BOOKS.

SINCE lecturers on the structure of matter usually begin their series at the present time with gases, because much more is known about gases than about solids and liquids, and since it is generally a gas which burns, and not the solid or liquid, a general treatise on fuel might open with gases. But coal remains our chief fuel, and if it is strongly rivalled now by gas, the gas itself is prepared from coal. Thus Professor J. S. S. Brame, F.I.C., Professor of Chemistry at the Royal Naval College, Greenwich, and lecturer on fuel at the Sir John Cass Institute, follows tradition in discussing "*Fuel Solid Liquid and Gaseous.*" [London: Edward Arnold and Co.; price 18*s.* net] in that sequence. Historically, moreover, he is justified in speaking of wood, peat and lignite before he comes to coal, and by his introductory chapter on combustion, ignition, calorific value, flame propagation, &c., he puts himself right theoretically. These general features should, however, have been discussed by themselves, and not as a first chapter to Part I., Solid Fuels. The volume before us is the third edition of Brame's well-known "*Fuel.*" A good deal had to be added to the second edition of 1917, particularly on carbonisation, powdered fuels, internal-combustion engines, velocity of combustion and standardisation tests. To the latter work, Professor Brame has himself made a notable contribution, and the active share, he has lately taken in the work of the Institution of Petroleum Technologists, is a guarantee that liquid fuels are not neglected. As regard low-temperature carbonisation, he naturally refers largely to the store of information contained in the reports of the Fuel Research Board, and these matters, like others, are incorporated in the text which has been re-written and do not merely form additional notes. Thanks to the copious references and the concise treatment the 388 pages of the volume supply a great deal of useful information. We should, however, have liked to have more on the importance of coal preparation and on distillation; in the chapter on calorimetry, the katarometer instruments should not have been overlooked, whilst a quotation from the *Frankfurter Zeitung* for 1911, on coke-oven gas for town use, might well have been omitted. Considerable developments may safely be early anticipated in fuel technology; they will come all the sooner, the more our actual knowledge is properly appreciated and disseminated.

Messrs. Bandenhoeck and Ruprecht of Göttingen have issued, under the title of "*Das Rotorschiff,*" a pamphlet on the Flettner rotorship, which is intended, we learn, to discount the sensational claims and assertions made by the reporters of the daily Press. They lay emphasis on the fact that the pamphlet is not issued to describe a "triumph der technik," but the results of 17 years' hard study and experiment. The author is Dr. J. Ackeret of the Aerodynamic Research Station at Göttingen. Professor Prandtl, who has done such remarkable work in elucidating aerodynamic theory, provides a preface, in which also a protest is entered against the sensational statements and claims for which the editors of the popular Press are responsible. The work is divided into three chapters, of which the first discusses streamline motion, both irrotational and rotational. The next deals with the so-called Magnus effect, and the third includes a careful study of the performance of the Buckau. The price of the pamphlet is 1 mark 80, and its publication may, it is to be hoped, serve a very useful purpose in obviating the danger of the public being misled into possible financial adventures.

The advent of high-speed machinery has made it necessary for the draughtsman of to-day to have a much better mathematical equipment than sufficed for his predecessor of, say, 40 years ago. The calculation of centrifugal stresses has nowadays to be frequently undertaken, and some cases, which have to be dealt with, are far from simple. With a view to providing assistance in this matter the Association of Engineering and Shipbuilding Draughtsmen has published in pamphlet form a paper by Mr. R. Gardner on "*The Strength of Rotating Discs.*" This describes in detail, methods of calculation and gives examples of their application to a number of practical cases. Copies can be obtained at the cost of 2*s.* each on application to the offices of the association at 96, St. George's-square, Westminster.

Having observed that a course of general introductory lectures into theoretical physics, which he had been delivering for twenty years, was attracting increasing numbers of students, Professor Felix Auerbach, of Jena, has published his "*Methoden der Theoretischen Physik*" in book form [Leipzig: Akademische Verlagsgesellschaft; price 13 goldmarks]. The few German books of a similar kind have been commonly too mathematical. The volume seems well adapted to facilitate the subsequent study of general physics and special branches of theoretical physics. The book opens with general principles, units and dimensions, and passes to elementary and differential equations, to the molecular theory and statistical methods, and, finally, to geometric, graphic and vector methods. The publication is intended for the student who has sufficient acquaintance with general physics to understand the numerous references to physical phenomena. The language is plain, though not always sufficiently direct, perhaps; some paragraphs read more like comments than expositions, and the definitions occasionally lack definiteness. We notice a minor peculiarity not unlikely to find favour. In analogy to Mathematik, Physik and Optik, Professor Auerbach speaks of Elektrik, instead of Elektrizität.

It is often a matter of surprise to lawyers that business men in general are willing to go on from day to day, entering into and carrying out contract involving heavy financial responsibility, without having even an elementary idea of the legal obligations involved in them. The majority seem content to trust more or less to luck, and to run to their lawyers when trouble arises. A comparatively small minority, however, are often on the look-out for a handbook written not for lawyers but for business men, which will give them some idea of the law bearing on their own line of business or trade. For these Sir Isaac Pitman and Sons, Limited, have a useful series of legal handbooks on such subjects as mercantile law, marine law, company law, the law of contracts, &c. The latest addition to this series is "*The Law relating to Building and Building Contracts,*" by W. T. Creswell, Barrister-at-law, Lic. R.I.B.A., &c. (7*s.* 6*d.* net). This little book should be of use not only to builders but also to engineering contractors generally. It explains the formation of contracts by means of tender, acceptance, and, it may be, formal contract, and the different kinds of contracts (*e.g.*, lump-sum contracts, measurement contracts, sub-contracts), the formalities to be observed in contracts with corporations and public bodies, the rights and duties of the parties to the contract and of the architect and surveyor, the rights of the parties in case of breach of contract, and many other matters of practical interest; and the contractor who reads the 169 pages of the text will have his

attention directed to many points worthy of consideration in the daily round of his business. The author is evidently thoroughly familiar with his subject, but he scarcely seems to appreciate the difficulty which the average layman has in understanding legal terminology, and, although he has devoted a chapter to the definition or explanation of many of the terms which he uses, he seems almost to forget at many points that he is writing for laymen and not for lawyers. The task of explaining law to laymen is, however, extremely difficult, and much must be forgiven to the lawyer who attempts it. Unfortunately, the earlier chapters are written in an extremely stilted manner, which is aggravated by an excess of punctuation. Semi-colons are used where a comma would suffice, and commas are used where they have no right to be. Indeed, the only way to read the book is to ignore the punctuation. At page 8 "exemptory contract" seems a misprint for "executory contract." On page 36 there is a surprising statement on the subject of the effect of the Statute of Frauds on building contracts not to be performed within a year, which should be reconsidered. The word "verbal" is used throughout the book where "oral" is meant. On page 119 "plant and lien" seems to mean "plant and materials." On page 157 the phrase "especially in districts or other circumstances" would suggest that a district is a circumstance. On page 160 (third last paragraph) the syntax of "whether . . . and" requires reconsideration; and, of course, "the question as to who" and "the question as to whether" crop up occasionally instead of "the question who" and "the question whether." Also, such colloquial expressions as "it is up to him" (page 50) should be excised. It is a pity that the book is not better written, but despite its defects of style it should be a most useful addition to Messrs. Pitman's publications.

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We may briefly mention two recent additions to the *Handbuch der Ingenieur-Wissenschaften*, which is issued in parts. The first of these, the seventh volume of "*Der Wasserbau. Landwirtschaftlicher Wasserbau, Fischerei, Dünenbau und Seedeiche*," a volume of 655 pages, deals with hydraulic works for agricultural purposes, drainage, irrigation, also the use of sewage; moors and their cultivation, and soil exposed to inundations; with the special arrangements to be made for fisheries in connection with such works, and river regulation; with dunes and their consolidation by means of plants; and with dykes, their sluices and the reclamation of flooded ground. The author, Paul Gerhardt, member of the Prussian Academy for Building Construction, died in 1923, and the final edition of this enlarged fifth edition of the book had to be entrusted to his colleagues. Gerhardt was a well-known authority on these subjects, and a conscientious writer. The other smaller book forms the second chapter of the second volume on "*Schachtbau*." This part had previously been compiled by Dr. W. Schulz, passing next through the hands of Professor O. Stegemann, while the third edition now before us has been rewritten by Professor H. Weihe, of Berlin. The 114 pages include shaft sinking by the freezing process, but does not especially deal with oil wells. Both the volumes are well illustrated and published by Wilhelm Engelmann, of Leipzig (prices 34 and 9 gold marks, bound).

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The Iron and Steel Institute.—No. 11 of vol. cix of the *Journal of the Iron and Steel Institute* has now been published by Messrs. E. and F. N. Spon, Limited, of 57, Haymarket, London. The work contains the papers presented at the autumn meeting of the Institute held at the British Empire Exhibition, Wembley, on September 4 and 5, 1924, which we reported in our columns at that time, together with the discussions and correspondence on them.

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Life-Saving at Sea.—Our attention has been called by the Director of the Conservatoire National des Arts et Métiers, 292, Rue St. Martin, Paris, III, to the exhibition, in that institution of apparatus and devices for saving life at sea. The exhibition is free to the public, and models can be entered to take part in the competition for the Anthony Pollock prize. This prize recalls the death at sea of Mr. and Mrs. Anthony Pollock, who were passengers on the La Bourgogne, and perished when that liner sank after a collision in a fog, in the year 1898. It was instituted in their memory by their heirs, who set apart at the time for the purpose of the prize a sum of 100,000 francs. The prize, under the deed of settlement, is intended to reward inventors, irrespective of nationality, of the best apparatus or devices for saving life at sea, exhibited in the Conservatoire. The sum available in any one year may all be awarded for one apparatus or device, or may be distributed to several inventors, at the discretion of an International Committee which includes amongst its members representatives of the United States and of this country. When in any one year any balance remains after allotment following the decision of the committee, such sum, in the committee's finding, may be used either for life-saving experiments or for increasing the number, or value, of the prizes to be distributed the following year. Further data may be obtained from the Conservatoire.

## HEALTH PROTECTION IN MINES.

The greater attention now given by various authorities to the problem of protecting operatives in the course of employment dangerous to health is reflected in the study of the question being actively pursued on both sides of the Atlantic. Quite recently a memorandum worthy of notice has been issued by the United States Department of the Interior, which contains an account of observations and experiments carried out by Dr. R. R. Sayers, chief surgeon of the Bureau of Mines, during such an investigation, together with accounts of a number of preventive measures recommended. It is well known that some mine dusts, notably those produced when lead, mercury, zinc, arsenic, and other metallic ores are being worked, have a very deleterious effect on the human skin, should they remain in contact with it for any length of time. In general, the greater the solubility of such dusts the more serious are their effects. For example, men are often badly poisoned when mining carbonate or oxide ores of lead, whereas such a condition is rare among those working only the sulphide galena. Again, the danger exists where the mining and smelting of mercury is in progress, particularly in proximity to reduction plant. Some dusts when inhaled irritate the lungs and cause a disease known by the general name of pneumoconiosis. Varieties of the complaint have been designated as silicosis when due to breathing rock dust, particularly finely-divided silica; anthracosis, or coal miners' phthisis, when due to coal dust; and siderosis when resulting from the inhalation of iron particles. It is well to note, however, that poisonous dusts are seldom found in coal mines, and that preventive measures in such cases are much more important than curative methods. Silicosis occurs in many of the hard-rock mining districts of the world. In Australia it is prevalent in both the gold and the silver-lead mines. The tin mines of Cornwall offer a homely example; in particular, the mining districts of the United States are widely affected by it.

Dr. Sayers has studied the effects of different dusts of known concentration on animals at the Pittsburgh Experimental Station of the Bureau of Mines. These dusts had previously been subjected to chemical and geological examination, and the fundamental types used have coal and quartz as their bases. The latter substance is widely used to "stone-dust" mines to prevent explosions, and was chosen for this reason. Limestone shale and kaolin were also experimented with, and as a result it was found that limestone dust, in the amounts usually occurring, was no more harmful than coal dust in its effect on the tissue, but that kaolin was detrimental and similar to finely-divided quartz. Statistics examined, according to the report, indicated that silicosis most frequently attacked machine men and shovellers in metal mines.

In the opinion of Dr. Sayers, dust from pure limestone, dolomite, gypsum, and anhydrite are preferable for use as dusting material. It is pointed out that roof shale when free from gritty material, as usually found in England, is extensively employed for this purpose, but some shales are open to the objection that they are too "sandy" or contain too much quartz or combustible matter. So far as Dr. Sayers has been able to ascertain, limestone dust is the safest physiologically, for use as a dusting material. Gypsum, or calcium sulphate, seemed to be practically harmless. The investigations made do not purport to be exhaustive or complete, but should be regarded rather as a step in the path to securing complete immunity for the worker engaged in these industries. The complete memorandum, which is entitled Serial 2,660, may be obtained from the Department of the Interior, Bureau of Mines, Washington, D.C., U.S.A.

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Diesel Motor Cargo Boats on the Rhine.—The Gute Hoffnungshütte Oberhausen, department Rheinwerft Walsum, has built six twin-screw cargo boats for the Rhenus Transportgesellschaft of Basle. The first of these boats, the Jupiter, is now plying between Rotterdam and Mannheim and goes higher up the Rhine to Basle when the water level permits. The boat has a length of 66·96 m. (219 ft.), a breadth of 8·98 m. (29 ft.), a draught of 2·7 m. (nearly 9 ft.), and can, with a draught of 2·3 m. (8¼ ft.), carry a cargo of 723 tons, including 30 tons of oil fuel. The boat is built in Siemens-Martin steel, and fitted with eight watertight bulkheads. The two Diesel engines are of the reversible four-cycle type of the Maschinenfabrik Augsburg-Nürnberg, and are not provided with compressors. At 250 r.p.m. they develop 200 h.p. each. They can be run at 60 r.p.m. and started from cold at that speed with the aid of two compressed-air cylinders, each of 2,000 litres (47 gallons) capacity, charged by a compressor driven off the propeller shaft and suffice for 52 successive manœuvres; the exhaust is utilised for the central heating. The dynamo is driven by a special 45-h.p. motor of the same type. The trial runs of the Jupiter proved, according to the *Schiffbau* of January 28, that the Flettner rudders greatly facilitated rapid manœuvring, *e.g.*, reversal at full speed within 24 seconds. Against a river current of 1·5 m. per second an absolute speed of 16·6 km. (10 miles) was maintained.

## CATALOGUES.

*Bearing Metal.*—A booklet explaining their "Eel" brand bearing metal is to hand from Messrs. Thermit, Limited, 155, Church-road, Battersea, London, S.W.

*Panel Ventilator.*—Several leaflets illustrating a metal ventilator panel for doors are to hand from the Van Zile Ventilating Corporation, 280, Madison-avenue, New York, U.S.A.

*Water Meter.*—A water meter, suitable for large, continuous deliveries is illustrated on a card received from Messrs. George Kent, Limited, 199, High Holborn, London, W.C.

*Sound Signals.*—A sound signal suitable for factories, railways, docks, &c., is described in a booklet received from Messrs. Klaxon, Limited, 36, Blandford-street, London, W. 1.

*Transformer Switches.*—Messrs. Johnson and Phillips, Limited, Charlton, London, S.E., have issued a new list of transformer tapping switches for the regulation of pressure on interconnected systems.

*Special Steel.*—A leaf catalogue relating to special steels suitable for the mandrel bars used in tube rolling is to hand from Messrs. Hadfields, Limited, Sheffield. The bars are supplied either in the rough or finished as required.

*Mixed Pressure Turbines.*—The English Electric Company, Limited, Queen's House, Kingsway, London, W.C., have issued a catalogue describing an improved type of mixed-pressure turbine using exhaust steam from reciprocating engines.

*Signal Lamps for Motor Vehicles.*—An electric lamp for motor vehicles and used at night for indicating the intention of the driver to stop or turn is dealt with in a circular received from the Harrod Manufacturing Company, 375, Queen's-road, London, S.E. 14.

*Cranes.*—A pamphlet illustrating many applications of their cranes to lifting and carrying operations in various industries has been received from Messrs. Herbert Morris, Limited, Loughborough. Electrically-driven overhead cranes and runways, and wall jib cranes are the principal types described.

*Heat Treatment.*—Automatic and Electric Furnaces, Limited, have sent us a card stating that they have a full equipment of electric furnaces at 175, Farringdon-road, London, E.C., where they are willing to undertake the normalising, hardening, tempering, &c., of tools, springs and machine parts.

*Electric Heaters.*—The Cressal Manufacturing Company, 40, Staniforth-street, Birmingham, have issued a catalogue of their electric heater unit, consisting of a flat steel-covered strip about 2 ft. long, which can be easily fixed, either singly or in any number, for heating rooms, offices, vehicles, &c.

*Pipe Fittings.*—Messrs. Crane, Chicago, U.S.A., have sent us a copy of their house periodical "The Valve World," which has now been published every month for twenty years. It contains illustrations of valves, steam separators, radiators and pipe fittings as well as articles of technical and general interest.

*Paint.*—Messrs. Thomas Howse, Limited, Smethwick, Staffs, have sent us a number of circulars dealing with lead, zinc, graphite, bitumen and iron oxide paints, and also enamels and varnishes, and a preparation known as "Derusta" for application to rusty surfaces. Most of the leaflets deal with tests of paints for particular purposes and describe the condition of the surfaces after exposure for considerable time.

*Steam Shovels.*—A catalogue of "Erie" steam shovels received from the British Steel Piling Co., Limited, 54A, Parliament-street, London, S.W., contains particulars of a 13-ton and a 20-ton machine, mounted on road or rail wheels or on caterpillars. Both are self-propelling and have all the usual movements for digging, slewing, and dumping. Full specifications and illustrations of working capacity and methods are given.

*Haulage Gears.*—A catalogue of several types of electrically-driven haulage gears, mainly intended for colliery work, has come to hand from the Carron Company, Falkirk. An adequate specification is given of each type, and some illustrations showing the condition of worms and worm wheels after six to ten years' constant service are printed, as an indication of the quality of the materials and workmanship employed in their manufacture.

*Steel.*—From Messrs. William Jessop and Sons, Limited, Sheffield, we have received a catalogue giving reproductions of their trade-mark labels with brief descriptive notes on their various steels for tools and special manufactures. These steels cover a range of requirements, being suitable for turning tools, taps, dies, saws, files, pens, cams, valves, springs, &c., as well as for heavy castings and forgings. The practical notes given in the catalogue are brief and clear.

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Shipping, Engineering and Machinery Exhibition.—A large amount of space has already been booked at Olympia in connection with the forthcoming Shipping, Engineering and Machinery Exhibition to be held from November 23 to December 5, 1925. This Exhibition has taken place at intervals during the last 20 years, and the latest promises to be unusually comprehensive, the Society of Motor Manufacturers and Traders having again decided to co-operate. Sir Chas. A. Parsons has accepted the Honorary Presidency of the Exhibition, Dr. Hele-Shaw and Captain Riall Sankey being chairman and vice-chairman respectively.

# "ENGINEERING" ILLUSTRATED PATENT RECORD.

## SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

*The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.*

*Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.*

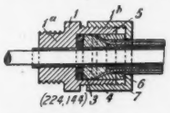
*Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.*

*The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.*

*Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.*

## ELECTRICAL APPARATUS.

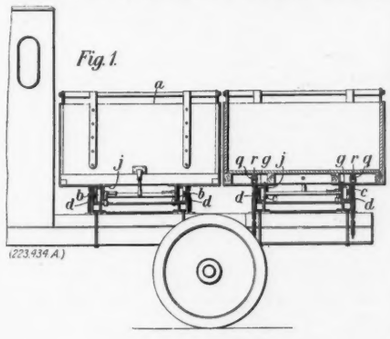
**224,144. H. D. Wight, Belfast, W. Park, Belfast, and The Sunderland Forge and Engineering Company, Limited, Belfast. Glands for Electric Cables.** (1 *Fig.*) March 11, 1924.—A gland for use with armoured and lead-covered electric cables, constructed according to the invention, is provided with a sleeve 1 having its bore so formed that one portion 1*a* provides a sliding fit for the lead-covered cable, and the other portion 1*b* is adapted to receive a metallic packing 3 arranged to pass over the cable and to be held in position against the shoulder formed between the

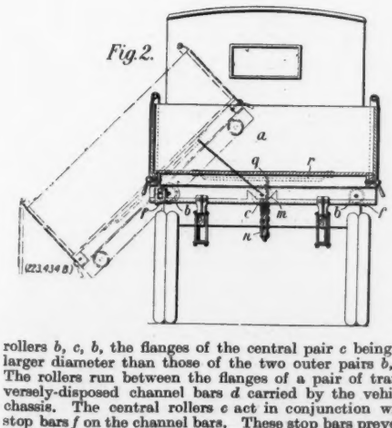



two portions of the bore, whereby the lead covering of the cable will be earthed to the gland. The packing is held in position by a loose truncated cone 4 with a hole through it, and which slides over the lead-covered cable, being forced into position by a ferrule or collar 6 so that the smaller end thereof is forced under the armouring 5 of the cable to keep the edge of the armouring from cutting the lead. The ferrule or collar 6 is forced against the cone 5 by a securing nut 7 and into good metallic contact with the armouring to earth and anchor or secure same. (*Sealed.*)

## MOTOR ROAD VEHICLES.

**223,434. The Forth Engine and Motor Works (Newcastle-upon-Tyne), Limited, Newcastle-upon-Tyne, and W. L. Paynter, Newcastle-upon-Tyne. Side-Tipping Vehicles.** (2 *Figs.*) December 10, 1923.—The invention relates to side-tipping bodies for road vehicles. A side tipping body *a*, in accordance with the invention, is mounted on three pairs of flanged

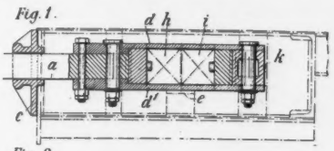


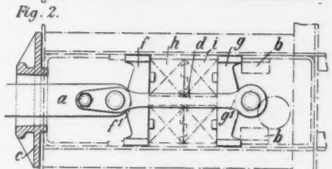



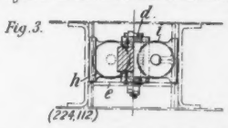

rollers *b*, *c*, *b*, the flanges of the central pair *c* being of larger diameter than those of the two outer pairs *b*, *b*. The rollers run between the flanges of a pair of transversely-disposed channel bars *d* carried by the vehicle chassis. The central rollers *c* act in conjunction with stop bars *f* on the channel bars. These stop bars prevent rollers *c* overrunning the channel bars. The outer rollers *b* coact with apertures *g* in the centres of the top flanges of the channel bars. The apertures *g* allow the rollers *b* to rise out of the channel bars when the body tips. The spindles of the rollers are carried by transverse angle bars *j*, which are notched on each side of the central roller spindle as shown at *m* and are adapted to coact with the top bars to prevent the body recoiling during the tipping movement. A pair of check chains *q* is provided, one end of each chain being fixed to the centre of the adjacent channel and the other end having a ring embracing and free to travel on a transverse rod *r* on the underside of the body. (*Sealed.*)

## RAILWAYS AND TRAMWAYS.

**224,112. G. H. Sheffield, London. Buffers and Draw Gear.** (5 *Figs.*) December 22, 1923.—The invention relates to buffing or draw gear or combined buffing or draw gear for railway rolling-stock of the kind having a spring-controlled buffing or draw-bar adapted to be movable laterally when transmitting pulling or pushing forces, but associated with means for automatically centring the bar when the force causing the lateral displacement ceases to act. The invention consists in buffing or draw-gear of the kind referred to, in which the coupler or buffer shank is rigidly connected to a spring-controlled bar, and is combined with means to enable the rigid member thus formed by the shank and bar to be movable laterally as a whole without affecting the position of the springs and follower plates associated therewith. In carrying the invention into effect, the central coupling buffer and draw-bar *a* is rigidly secured to two links *d*, *d*$^1$ supported by a cross frame member *e* and adapted to support two blocks *f*, *g* which can slide longitudinally in the frame and which are controlled by side springs *h*, *i*. The rear end

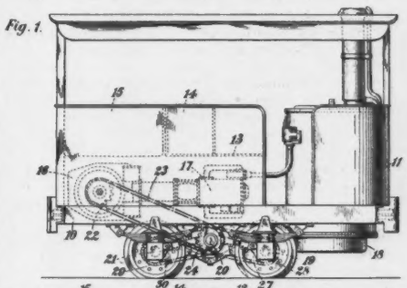


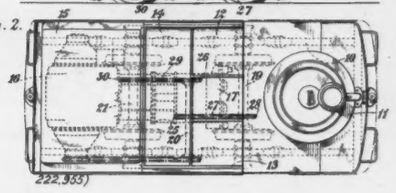




of the bar *a* is rounded so as to seat itself in a central depression *f*$^1$ in the block *f* while the rear ends of the links *d*, *d*$^1$ are pinned to a wearing member *k*, which is also rounded so as normally to seat itself in a central depression *g*$^1$ in the member *g*. The members *f*, *g* are also inclined on each side of the central depressions so that if the buffing gear gets out of centre (as would happen, for example, if the buffing shock were taken when the vehicle is rounding a curve) the action of the springs between the members *f*, *g* combined with the inclined arrangement of such members will ensure that the buffing gear will automatically centre itself with the appropriate parts, seating in the central depressions *f*$^1$, *g*$^1$ of the members *f*, *g*. When transmitting the tractive effort the end of the draw-bar will move out of contact with the member *f* and will be free to swing round the depression *g*$^1$ within the limits imposed by the play in the socket *c*. Conversely, when the draw-bar is subject to compressive force, the member *k* will move away from the member *g*, and the draw-bar will be free to swing laterally round the depression *f*$^1$ within the limit imposed by the projecting stops *b*. (*Sealed.*)

**222,955. S. E. Alley, Westminster, London, and L. E. Slade, Westminster, London. Locomotives.** (4 *Figs.*) July 11, 1923.—The invention is particularly applicable to locomotives for light railways. On the upper surface of the chassis frame 10 of the locomotive there is arranged at the extreme front end the major portion of a vertical steam boiler, 11. Behind this are seats 12 and 13 for the operators, and behind these a fuel bunker 14. Towards the extreme rear of the vehicle there is provided a water tank 15 underneath which is a casing 16 enclosing a transverse transmission shaft which is the crankshaft of a steam engine. This is arranged with its bearings mainly or wholly above the frame 10. Also mainly or wholly above the frame 10, but forward of the casing 16, are the engine cylinders 17. These are situated midway of the width of the vehicle and underneath the water tank 15, fuel bunker 14 and seats 12 and 13. Underneath the frame 10, at the front end thereof, are various fittings, including the ash box 18 of the boiler 11. These stand forward clear of the front vehicle axle 19, which is immediately behind them. Next behind the axle 19 is a transverse driving countershaft 20, and behind this again the rear vehicle axle 21. At the off side of the vehicle the engine crankshaft, which is mainly enclosed in the casing 16, is provided with a sprocket wheel 22 and is connected by a chain 23 with another sprocket wheel 24 upon the counter-shaft 20. The counter-shaft 20 also has upon it two other sprocket wheels 25 and 26 whereof the former is connected by a chain 27 to a sprocket wheel 28 upon the axle 19. The wheel 26 is similarly connected by a chain 29 to a sprocket wheel 30 upon the axle 21. It will readily be apparent that the particular

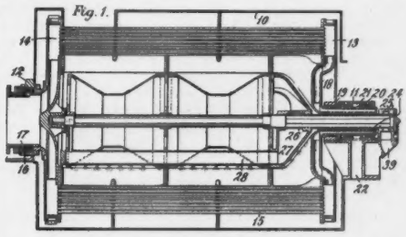


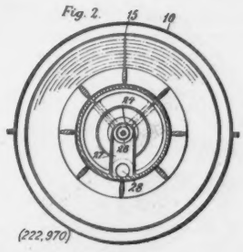




arrangement of the parts shown affords ready access to the under parts of the boiler and the casing 16, while at the same time adequate and well-balanced transmission of the drive to the axles 19 and 21 is ensured. The engine cylinders are also easy of access since a space can be left between the seats 12 and 13. (*Sealed.*)

## STEAM ENGINES, BOILERS, EVAPORATORS, &c.

**222,970. The Ramsay Condensing Locomotive Company, Limited, Glasgow, G. F. Jones, Cheadle Hulme, and T. L. Hale, Bolton. Evaporative Condensers.** (2 *Figs.*) July 13, 1923.—The object of the invention is to provide a condenser in which the wetting of the tubes with a film of liquid is affected in as short a time as possible, in order that the maximum condensing effect can be obtained. According to the invention, instead of providing a trough of water in which the tubes are immersed to wet them, there is provided a liquid-spraying device so situated with respect to the bank of tubes as to provide a curtain of liquid which will wet the outer surface of the tubes in a short time as they pass through the curtain in their rotation. The evaporative condenser comprises an outer casing 10 provided at each end with bearings 11, 12. At each end of the

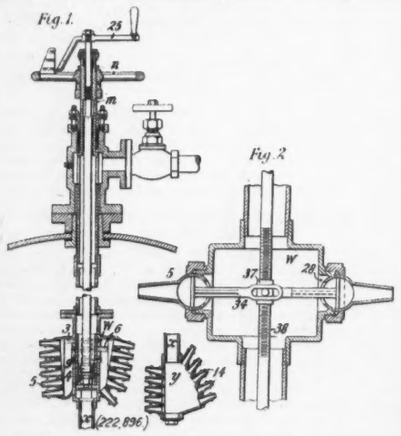



casing there is an annular header 13, 14, and a bank of tubes 15 extends between the headers. The inlet-header 14 is mounted on a suitable hollow disc-shaped casting which provides a trunnion 16 rotatable within the bearing 12. Within the trunnion 16 is a tubular member 17, which constitutes the inlet for the steam to be condensed. The outlet-header 13 is connected by radial pipes 18 to a tubular shaft 19 rotatable in the bearing 11. Openings 20 in the shaft 19 communicate with an annular space 21 in the bearing, and through it with an outlet 22 in the frame supporting the bearing, this outlet 22 constituting the means whereby the condensate is withdrawn from the condenser. Within the hollow shaft 19 is mounted a stationary hollow shaft 24 supported at its outer end in a bracket 25, and extending inwards to inside the bank of tubes 15. At its inner end it is provided with lateral openings 26 to afford

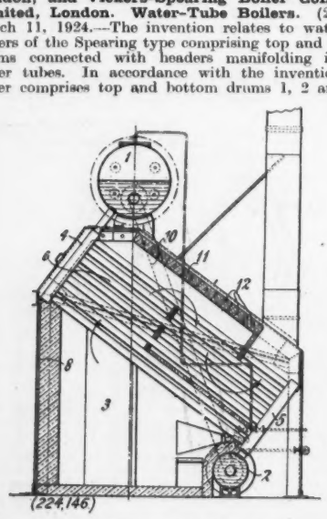
communication to a chamber 27 (see Fig. 2) which communicates with a pipe 28 extending lengthwise of the bank of tubes and situated inside them and opposite the lowest point of the bank. The hollow shaft 24 is provided with lateral openings at its outer end which communicate with an inlet passage 39. The inner end of this shaft is closed so that cooling water supplied through the inlet 39 is caused to pass through the shaft 24 and chamber 27 into the tubular member 28. The tubular member 28 is perforated or slotted along its lowermost surface to form a series of spraying jets, or a continuous jet, whereby cooling water supplied through the inlet 39 is delivered as a curtain spray on to the bank of tubes 15. In the operation, the steam is admitted by the pipe member 17 to the header 14, and passes thence into the tubes 15; cooling water is pumped in through the inlet 39 and projected as a curtain spray on to the tubes 15. The structure carrying the bank of tubes is rotated so that all the tubes are passed in turn through the curtain spray and effectively wetted. (*Sealed.*)

**222,896. C. H. Batty, Stalybridge. Steam Boilers.** (9 *Figs.*) April 6, 1923.—In apparatus for removing mud and scale from the interior of a steam boiler or the like and for supplying feed-water thereto, hot water is led into the boiler through a rotatable pipe *m*, Fig. 1, terminating in a number of nozzles 5 projecting from a distributing chamber *w*. Series of nozzles project in different directions from separate compartments or passages 4 in the distributing chamber. The hot water



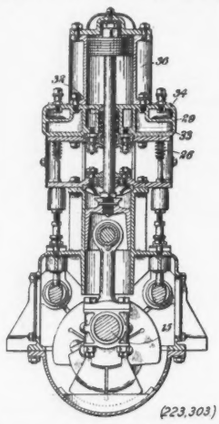

passes into the different compartments through ports 3, 6, 9 under the control of a sliding tubular valve 15 operated by a hand wheel 25. A pipe *x* forming a continuation of the supply pipe *m* beyond the chamber *w* terminates in a lower chamber *y* fitted with nozzles 14. In a modification, jets 5, Fig. 2, are formed with spherical inner ends which engage with spherical bearings in the distributing chamber *w*. A rod 38 rotated by a hand wheel carries a nut 37 engaging the slotted ends of arms 34 fixed to opposing nozzles. (*Sealed.*)

**224,146. J. Kerr-Bock, London, K. A. Spearing, London, and Vickers-Spearing Boiler Company, Limited, London. Water-Tube Boilers.** (2 *Figs.*) March 11, 1924.—The invention relates to water-tube boilers of the Spearing type comprising top and bottom drums connected with headers manifolding inclined water tubes. In accordance with the invention, the boiler comprises top and bottom drums 1, 2 arranged



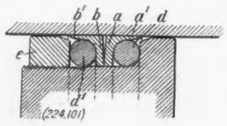

transversely of the furnace 3, headers 4, 5 communicating with the drums, inclined water tubes 6 connecting the headers, a boiler casing 8, a refractory lining 11 to the casing, and hollow rods or tubes 12 through which air, water or other cooling medium can be circulated supporting the refractory lining in the upper part of the boiler casing. In the improved boiler, according to the invention, the water tubes 6 are preferably arranged at a greater inclination to the horizontal than is usual in boilers of this type to increase the height of the combustion chamber, and the usual downcomer 10 connecting the top and bottom drums 1, 2 is located outside the boiler casing to enable the dimensions of the latter to be still further reduced. (*Sealed.*)

**223,303. S. E. Alley, Westminster, London. Fluid-Pressure-Operated Engines.** (6 *Figs.*) July 17, 1923.—The invention relates to that type of engine in which the main body or shell is built up of the following constructional units succeeding one another and comprising a cylinder block, a support for the crank-shaft, and a valve chest for poppet or other valves, which valve chest is formed as a constructional unit complete in itself, is situated between the cylinder block and crank-shaft support, and is the principal or only connection between such parts of the main body or shell of the engine as are separated by it. According to one feature of the invention, there is provided an




engine of the type described which is characterised in that in the constructional unit constituting the valve chest 29 the valves (for example, poppet valves) have their stems and operating rods 26 disposed parallel to the longitudinal axis of the cylinder 36, and extending to a position adjacent to the crank-shaft 15. According to another feature of the invention, the conduits 32, 33, 34 for supplying operating fluid to, or withdrawing fluid from, both ends of the cylinder or cylinders all pass through (for example are formed in) the interior of the valve chest unit 29. The length of such conduits situated outside of the engine is thus reduced to a minimum. (*Sealed.*)

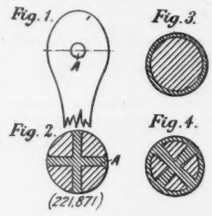
**224,101. R. A. Blakeborough, Brighouse, and W. J. Boyd, Brighouse. Packings for Pistons.** (1 *Fig.*) December 1, 1923.—According to the invention, in a packing which is designed particularly for a piston or plunger acted upon by fluid, the periphery of the piston or plunger is provided with one or more rings *a*, *b* of flanged form and adapted to receive between the flange *a* or *b* and the body of the piston or plunger a ring *d* or $d^1$ of rubber. The backs or outer faces of the radially extending portions of the metal rings *a*, *b* are inclined, so that an annular space is left between their peripheries. If only one ring is employed, it is arranged




to abut against a shoulder on the piston or plunger, the inclination of the back of the ring leaving a peripheral annular space between the ring and the shoulder. The flanges $a^1$, $b^1$ of the rings are tapered and terminate in relatively sharp edges, opposed to the direction in which the fluid pressure acts. A pressure member *e* working on a screwed part of the piston or plunger is provided to enable pressure to be applied axially to the rubber rings *d*, $d^1$, the consequent radial expansion of the tapered flanges $a^1$, $b^1$ of the metal rings forcing them tightly outwards against the surface of the bore or cylinder in which the piston or plunger works. (*Accepted November 12, 1924.*)

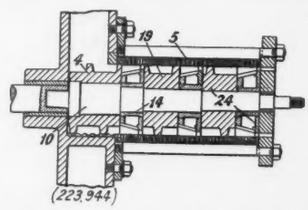
## MISCELLANEOUS.

**221,871. D. M. Findlay, Newcastle-on-Tyne, Reinforcing Wood.** (7 *Figs.*) June 20, 1923.—The invention refers to strengthening or reinforcing bodies composed of wood and consists in providing a transverse or cross bond (or bonds) composed of material which, while in a plastic, fluid, semi-fluid or like condition, is filled into a receptacle (or receptacles) formed in the wood, interlocking transversely therewith subsequently by solidifying and comprising portions visible in opposite sides at the surface of the body and surrounded by or contained between material of the body at the surface. The material used may be a metal, an alloy, an amalgam, composition or the like, and generally of such a nature that in its normal condition or ultimately by development, it possesses a tensile strength greater than that of the wood with which it is to be associated, and also is such that it may be applied without deforming and without detrimentally affecting the wood to an appreciable extent. The handle illustrated is reinforced by material A filled into transverse holes which, as illustrated, are diametrical and intersect at the axis of



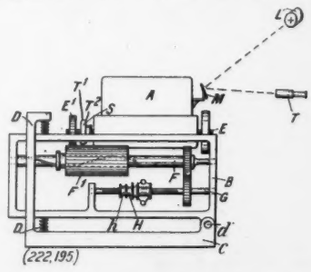

the handle. In Fig. 2 the holes, which may be tapered, so as to be of greater diameter at the periphery of the handle than at the axis, are enlarged at the periphery of the handle. As illustrated they are countersunk. (*Sealed.*)

**223,944. A. W. Sizer, Hessle. Compressing or Moulding Plastic Substances.** (12 *Figs.*) April 30, 1923.—The object of the invention is to express a desired quantity of liquor such as oil from oil-bearing seed and at the same time to form the residue of solid of semi-plastic material into cakes or cubes which can be readily handled. The machine of the invention




comprises feeding worm sections 4, 19, 24 rigidly attached to a driving shaft 10, and a chamber 5 within which the worm sections rotate. This is provided with ducts through which the expressed liquor can escape. There is also a series of die plates 14 having tapering die passages arranged alternately with the worm sections within the chamber 5 through which the material is extruded. (*Accepted November 12, 1924.*)

**222,195. A. J. H. Elverson, Wimbledon, London, and Herbert Kennedy and Company, Limited, Westminster, London. Apparatus for Testing Balance of Rotating Machinery.** (1 *Fig.*) June 25, 1923.—Comprises a method and apparatus involving the use of a stroboscope. The machine A, for instance, a motor car engine is mounted on a frame B in a manner similar to that in which it is mounted on the car frame, the frame B being pivoted at *d* to a bed plate C between which and the frame is a spring D. The shaft E of the machine drives a parallel shaft F through the medium of a toothed wheel $E^1$ and a long pinion $F^1$ helically splined to the shaft F. This shaft drives a parallel shaft G upon which is an adjustable out-of-balance mass system H. The system H comprises unequal weights carried by pairs of links of different lengths so that in one position they are balanced. With the system H adjusted in this position, the machine is run up to the critical speed and the vibrations are viewed by the




following means. A stroboscopic flash-timing apparatus *s* is mounted on the shaft E and electric leads $T^1$, $T^2$ taken off to a lamp L, an index on which, for instance, a cross is thus illuminated synchronously or nearly so with the machine. An image of this index in the mirror M is viewed through the telescope T provided with reticulated cross-hairs. The masses are then adjusted radially by moving the collar *h* and the phase adjusted by sliding the wheel $F^1$ to bring vibration to a minimum. The system H is next moved axially along the shaft G until the position of minimum vibration is reached. From the adjustments made a measure of the degree of lack of balance of the machine can be found. Sometimes the vibrations are due to harmonics caused by out-of-balance masses on secondary shafts. These may be investigated by driving the disturbing system at the requisite multiple or fraction of the speed of the main shaft, the time flashes being correspondingly adjusted. (*Sealed.*)